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ORCLE Program Metrics

Phase	Event	Metric Criteria
Phase 1	Range Demo [White Sands Missile range, Government Furnished]	RANGE DEMO of HYBRID FSO/RF Link Mountain top to Mountain top as surrogate Air-to-Air (~50 km separation) Mountain Top to Ground as surrogate Air-to-Ground Link (~12 km separation) Measure GTT LCA >95% MDR >2.0 Gbps MRR MDR >45Mbps at 12 km Pointing, Acquisition, & Tracking operational, Model performance for conditions in Korea during July for a 10 node hybrid network over a 400 km TOTAL RANGE with 2 ground nodes
Flight Test	Flight Demo [Range TBD, Government Furnished]	FLIGHT DEMO – Ground-to-Air-to-Air of HYBRID FSO/RF Link Measure GTT LCA >95% MDR >2.0 Gbps FLIGHT DEMO – Mobile Ground-to-Air Model performance for conditions in Korea during July for a 20 node hybrid network over a 1000 km TOTAL RANGE with 2 ground nodes MRR MDR >45Mbps at 20 km

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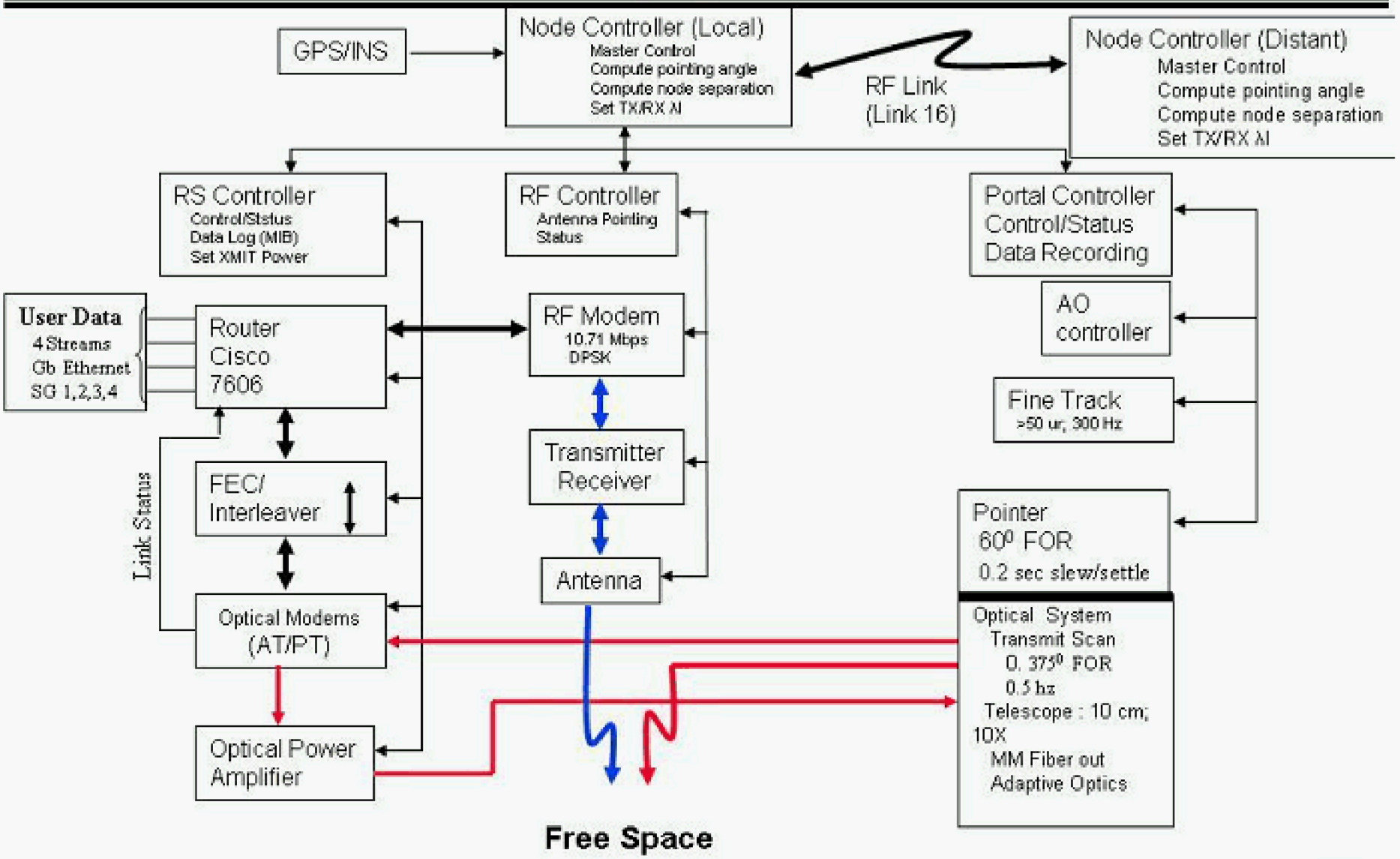
ORCLE System Overview



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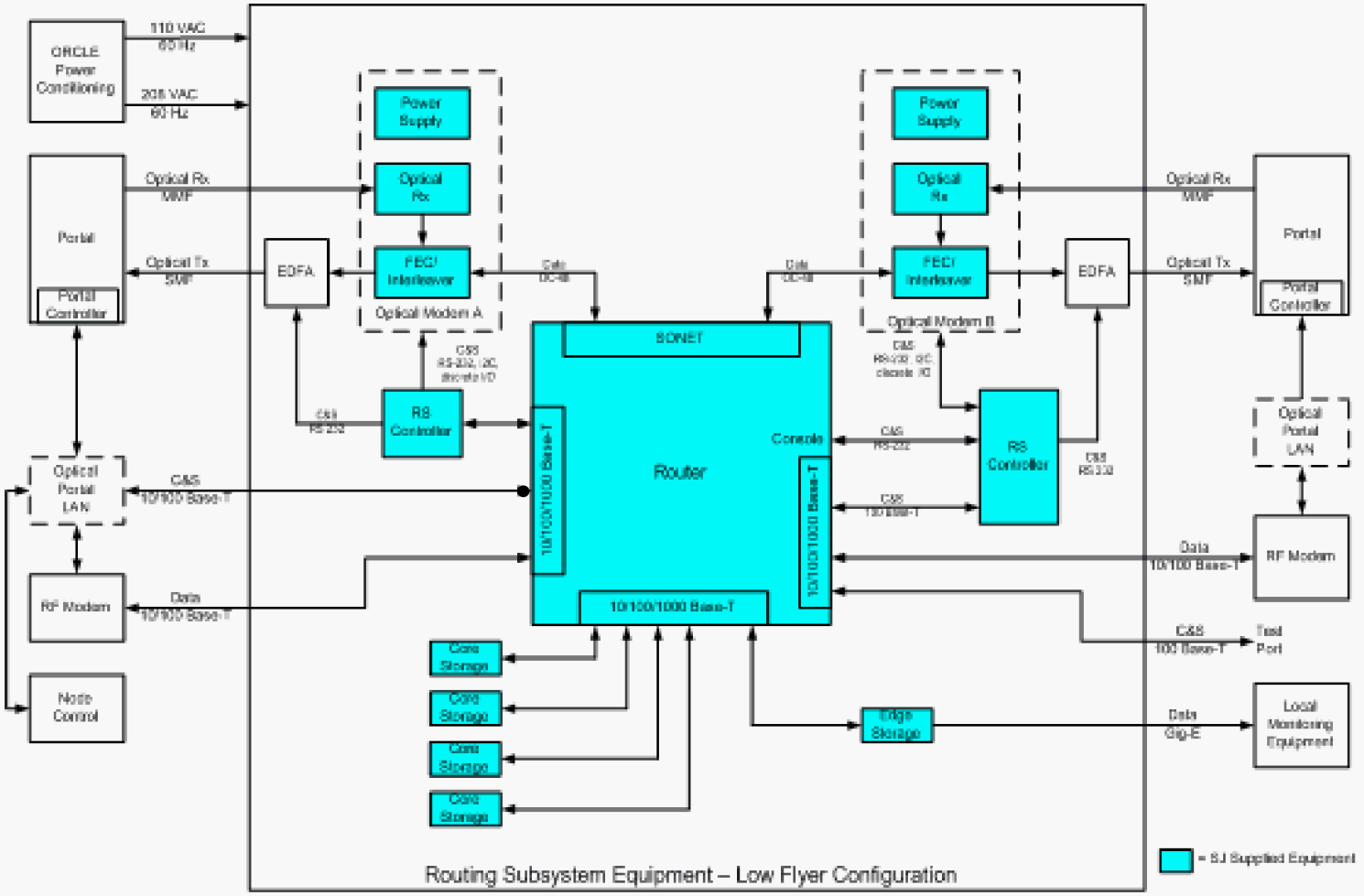
ORCLE Node Configuration



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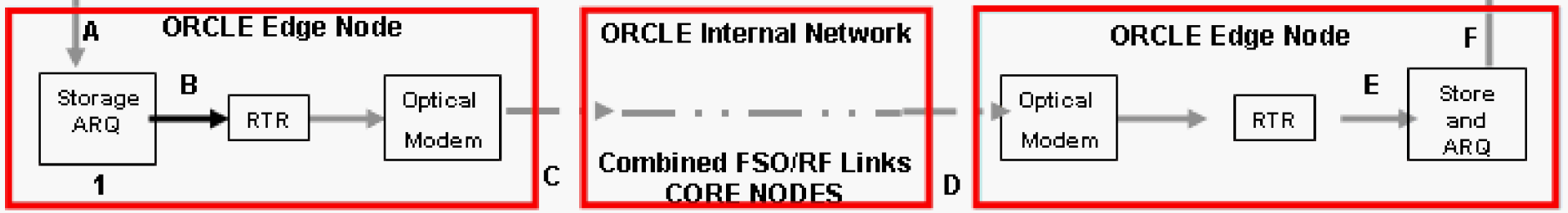
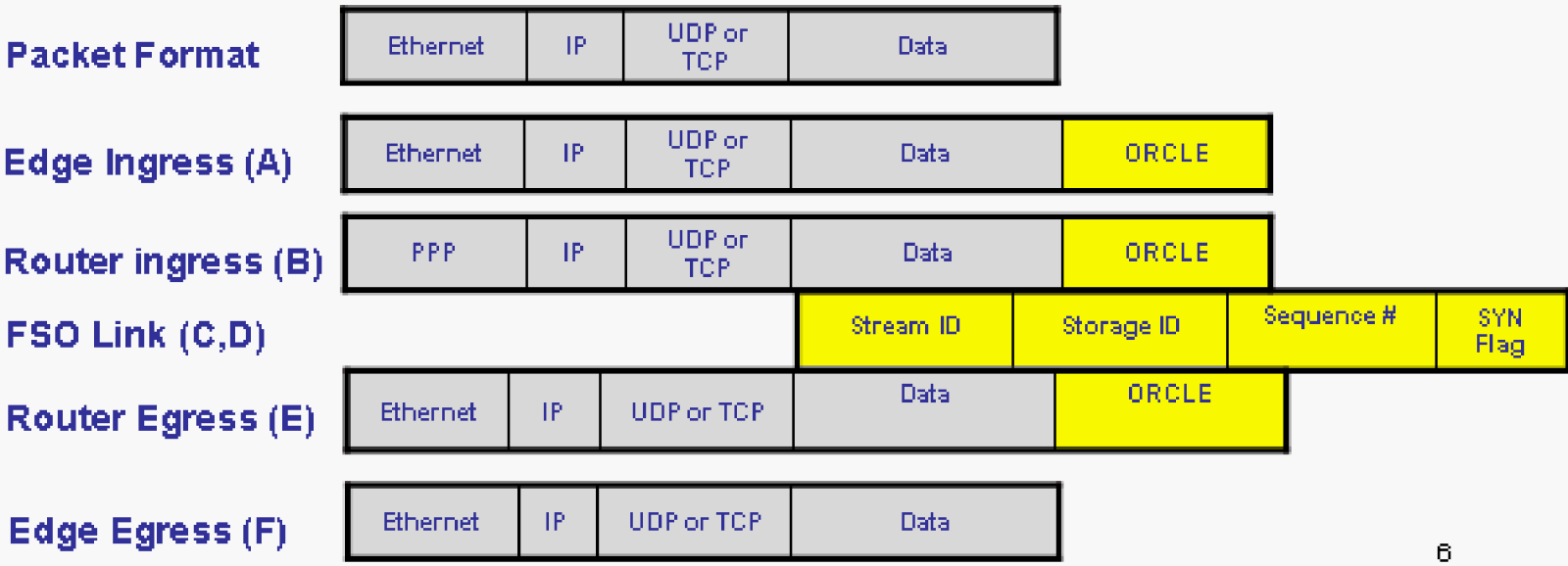
ORCLE Packet Formats



Service Group	Channel Media	Data Rate	Storage
1	RF	10 Mbps	No
2	RF or FSO	10 Mbps	Yes
3	FSO	2.38 Gbps	Yes
4	FSO	2.38 Gbps	No



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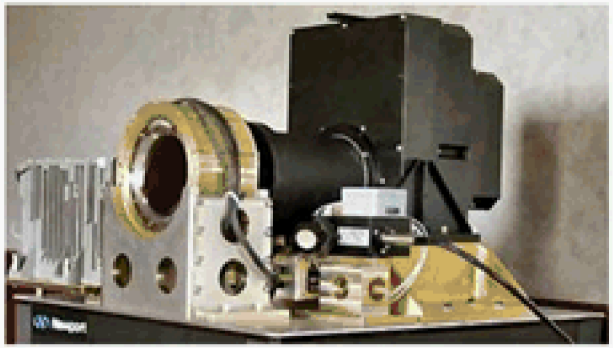
Optical Terminal Types

Gold



Bronze

Top Level Optical Terminal Requirements

Field of View	≥ 6.5 mr
Tx Beam Divergence	200/80 ur
Receive Aperture	10 cm
Optical Loss- Space to Fiber	3 dB
Tx/Rx Optical Isolation	≥ 80 dB
Operating Wavelengths	1545, 1564 nm
Wavefront Correction	2 Wavelengths @ 50 Hz

Silver

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Tactical Common Data Link Hardware

- ORCLE is RF agnostic
- TCDL-N (Navy) converted to Annex B
- Ku Band
- Rates Utilized: 10.71Mb/s possibly 45Mb/s
- Interfaced to router via 10/100 Ethernet

High-gain Option

ORCLE Baseline

ATE

Airborne Terminal Equipment

STE

Surface Terminal Equipment

L3 communications

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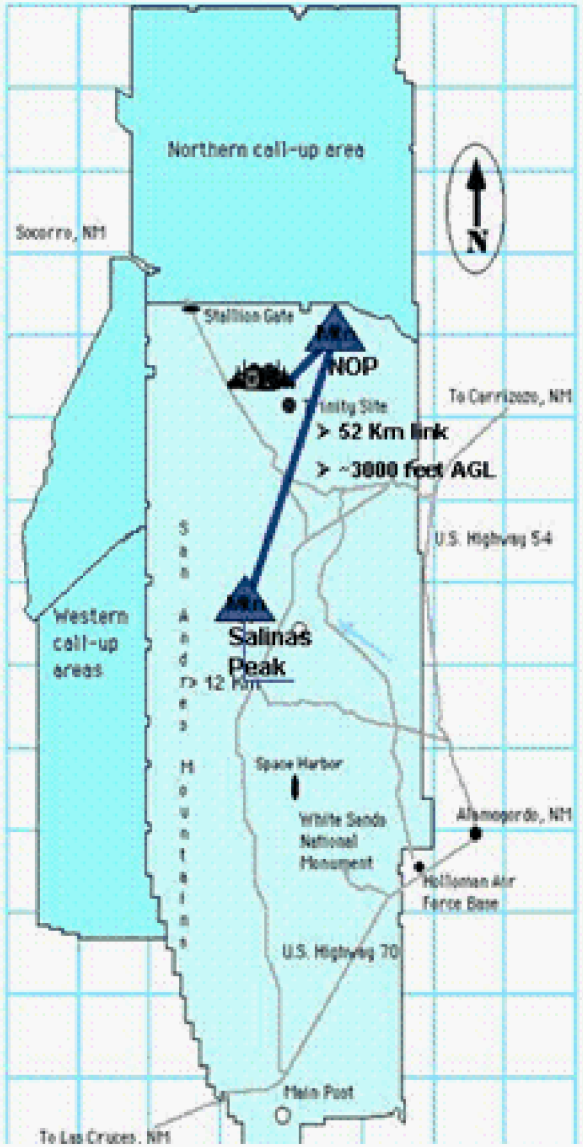
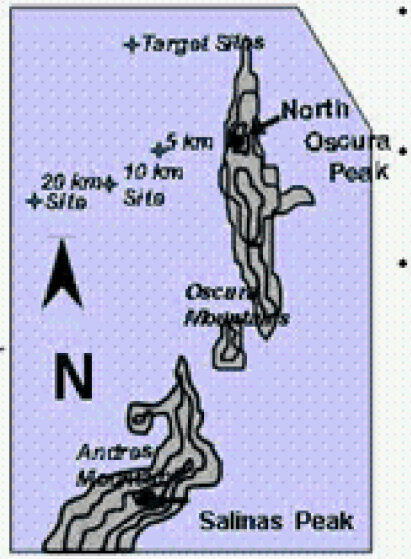
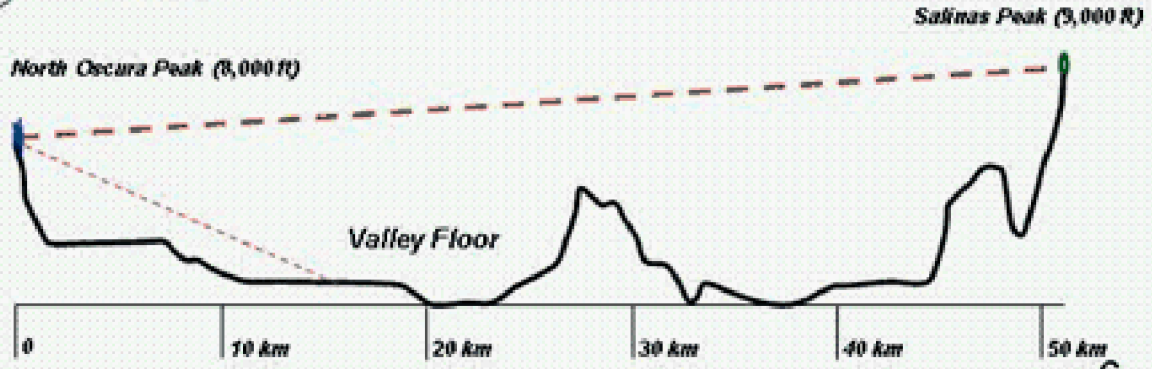
Phase I Ground Link and Network Test--October 2005





White Sands Missile Range Requirements: Simulate Air-Air & Air-Ground

- Prototype and install hybrid RF/FSO link on two mountain tops and one ground station.
  - Test Period two weeks (~16 months after contract award)
- A-A Two mountain top sites (North Oscura Peak & Salinas Peak)
  - Separation distance of ~52 km
- A-G Mountain top to valley floor ground node
  - Separation distance of ~12 km
  - Active and MRR



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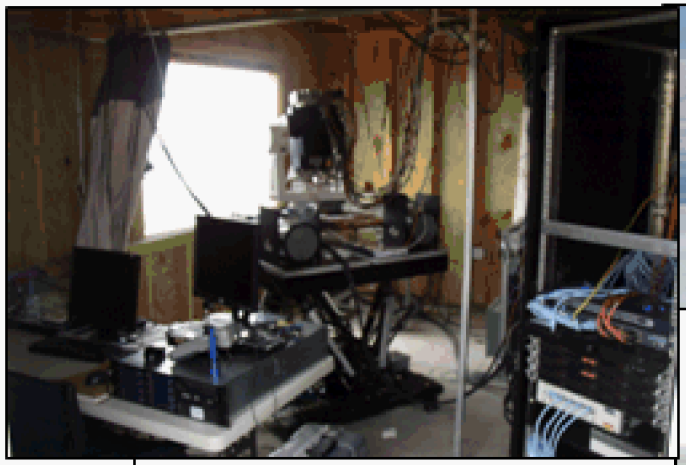
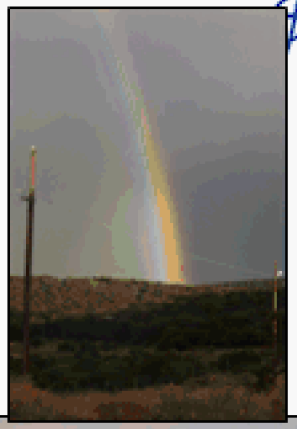
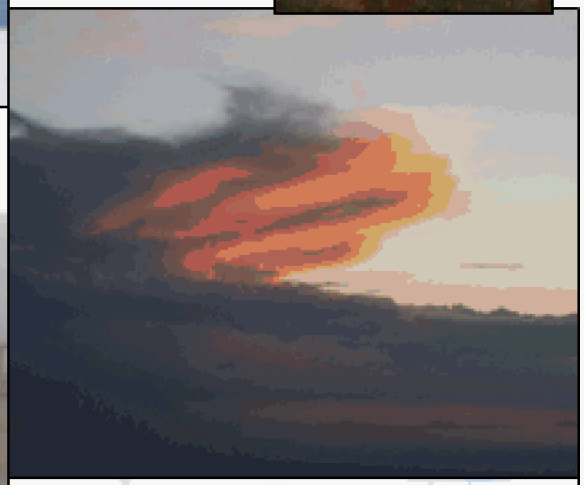
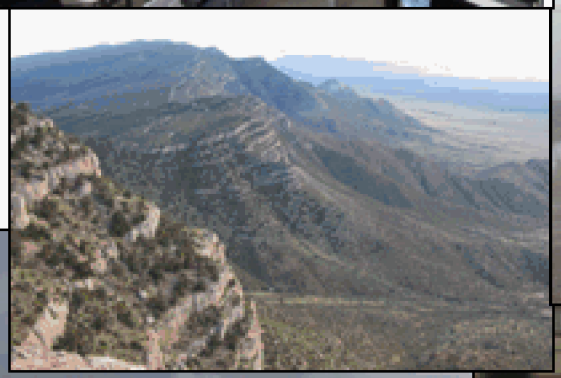
White Sands October 2005

An Eternity into 2 weeks





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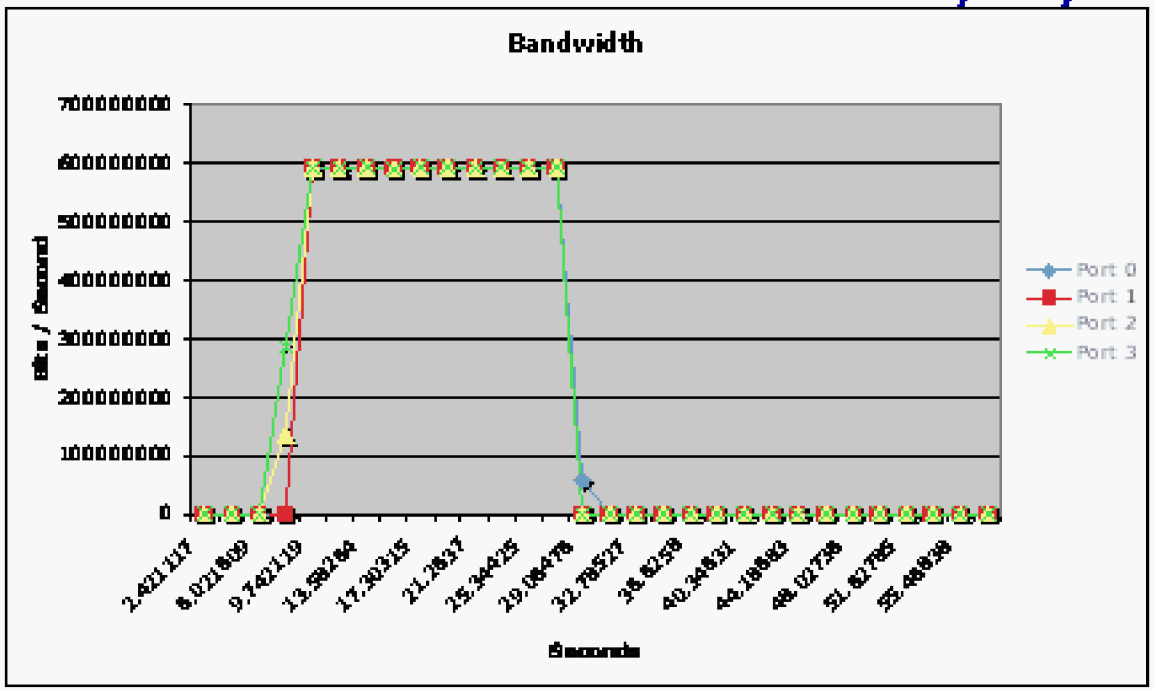
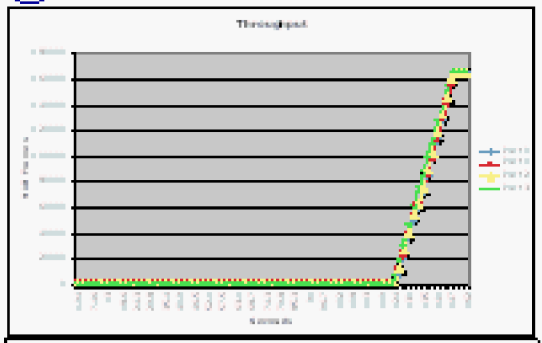
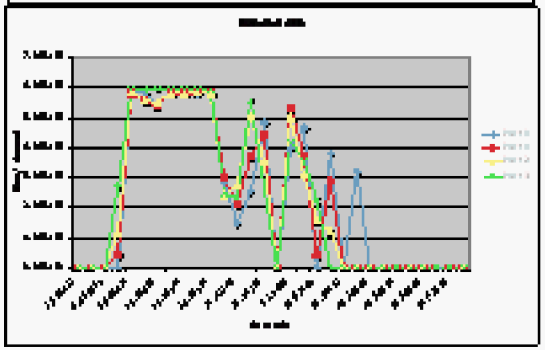
WSMR Test Data: 6 GB File Transfer

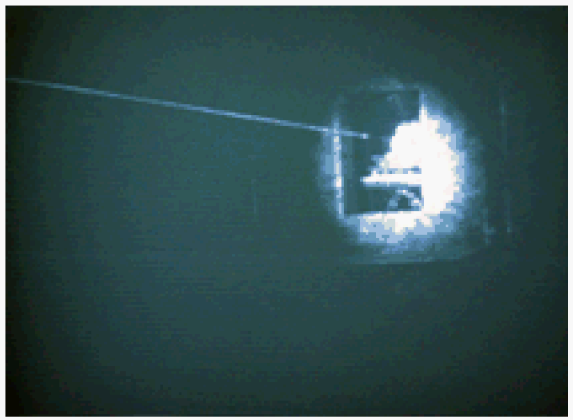
WSMR 1: Oct 2005, NOP to Millers Watch (12 km)

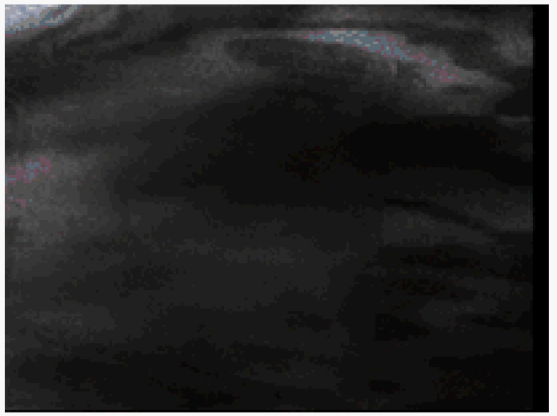
Link Metrics Data Generated by Terry Gibbons @ MIT/LL











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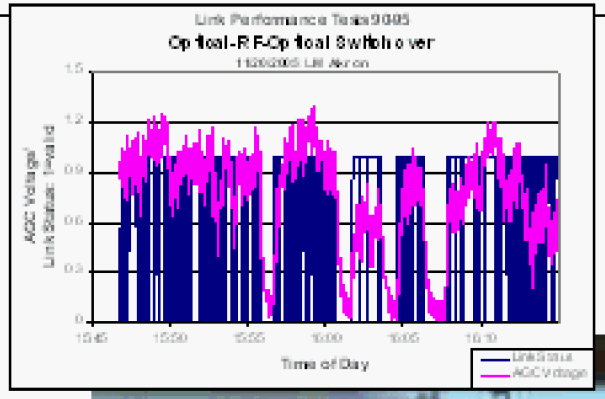
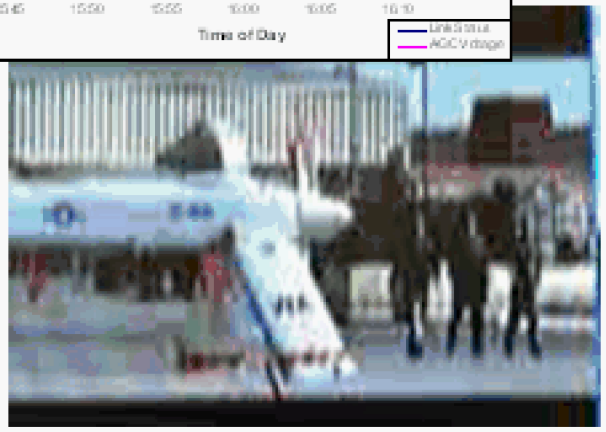
November 2005 Test

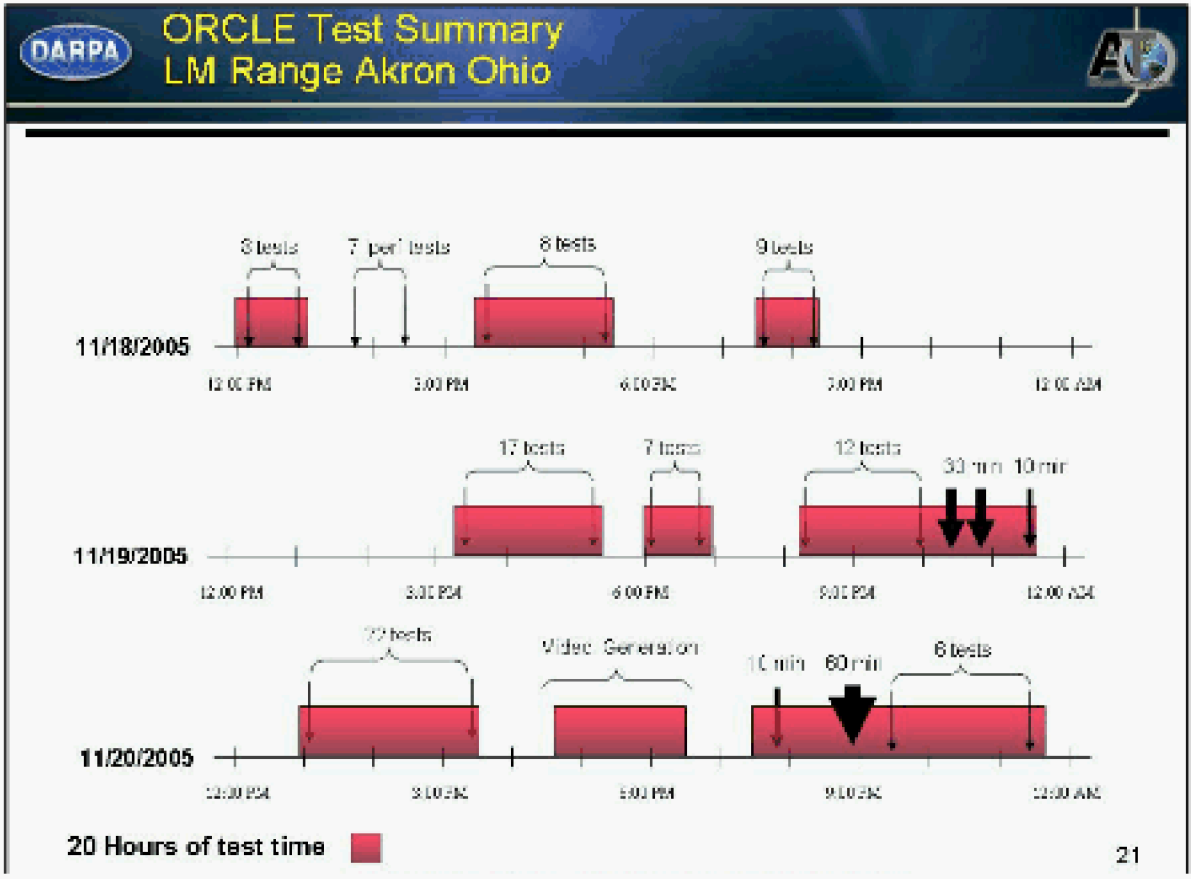
Lockheed Martin Akron 1.6 km Range





Link Metrics Data and Video Generated by Terry Gibbons @ MIT/LL

2.0 Mbps sustainable data rate



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ORCLE Phase 2

- Awarded March 2006
- Utilize hardware from Phase 1
  - Additional hardware as required
- Repair Damage from WSMR
- Incorporate upgrades/Lessons learned
- Added 2 WSMR Tests
- Flight Test Originally Planned Nov 2007

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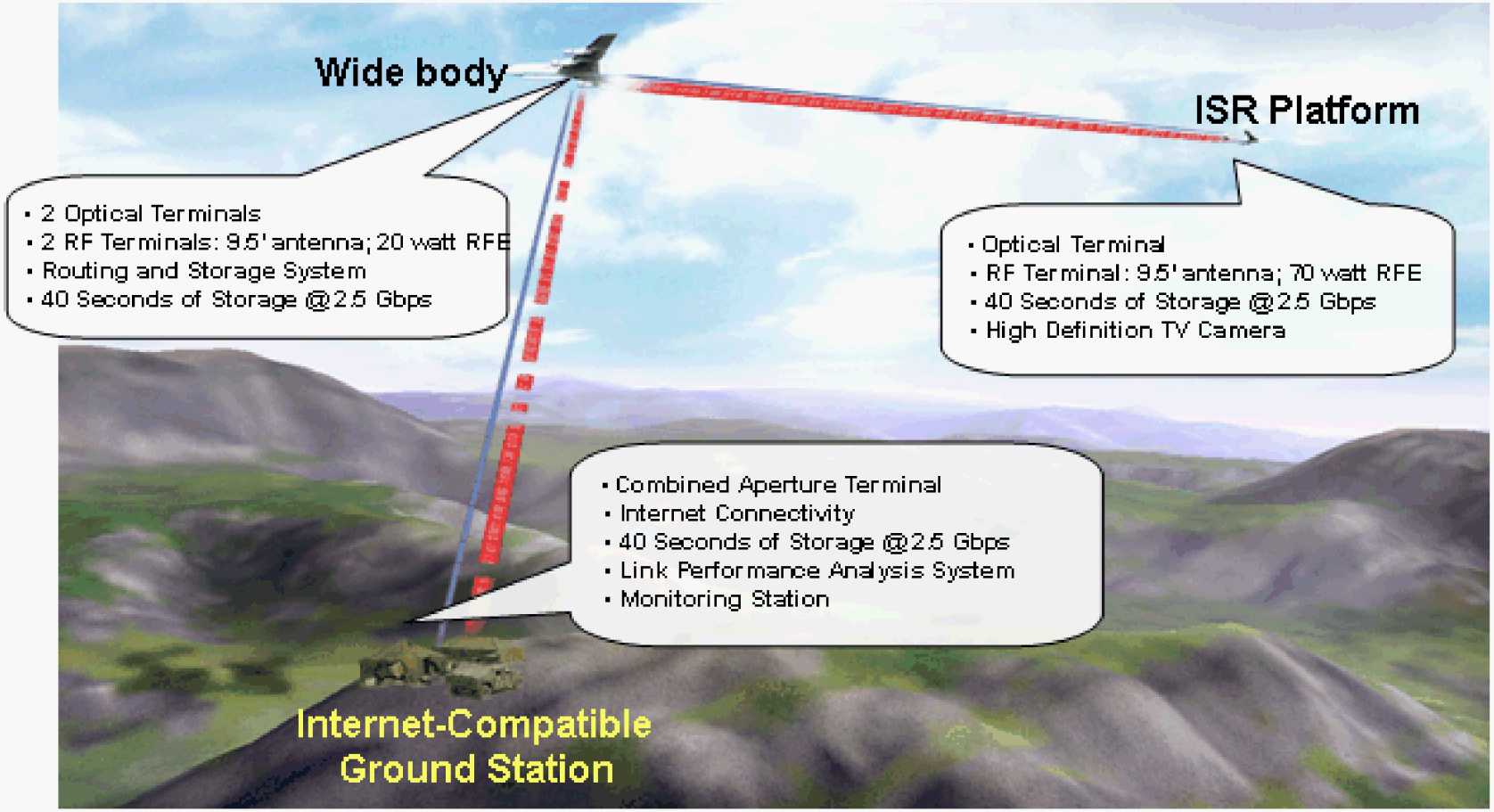
Program Objective

- *Develop physical hardware and protocol software to demonstrate a hybrid free space optical/radio frequency mobile airborne communications network consisting of active and passive terminals*



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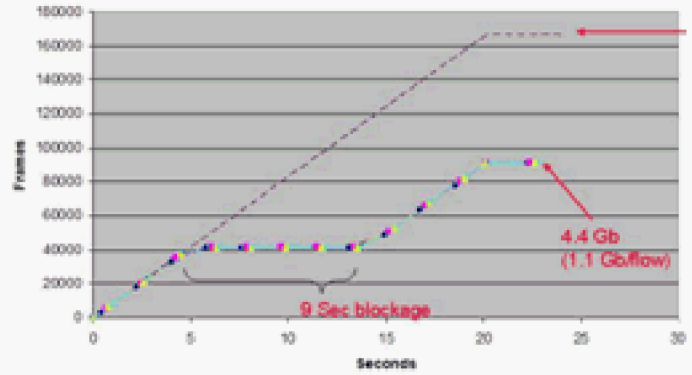
September 2006: Network Testing

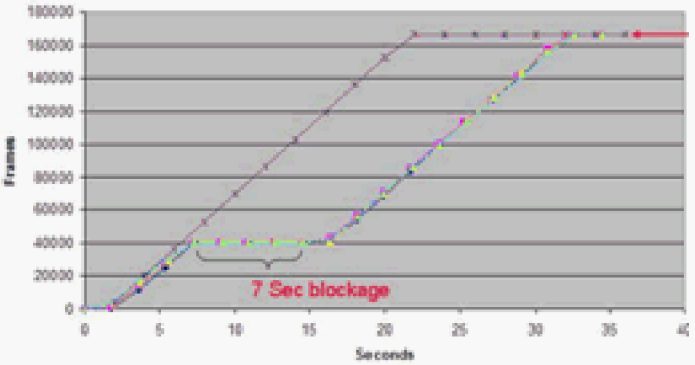
Optical Path: 6 GB files: RF Path: 22 MB

Out of Sequence packets = 0; Dropped packets = 0

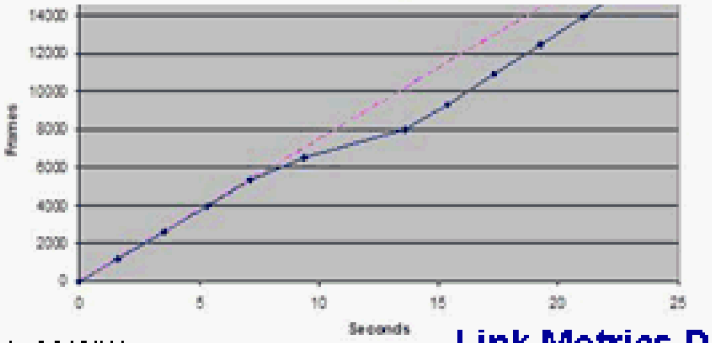
2.4 Gbps sustainable data rate



SG 4: Optical Only, No Storage
Space Shuttle Launch Video



SG 3: Optical Only, With Storage
Matrix "Lobby Segment"



SG 2: Optical/RF Switchover
Predator

Link Metrics Data and Video Generated by Terry Gibbons@ MIT/LL

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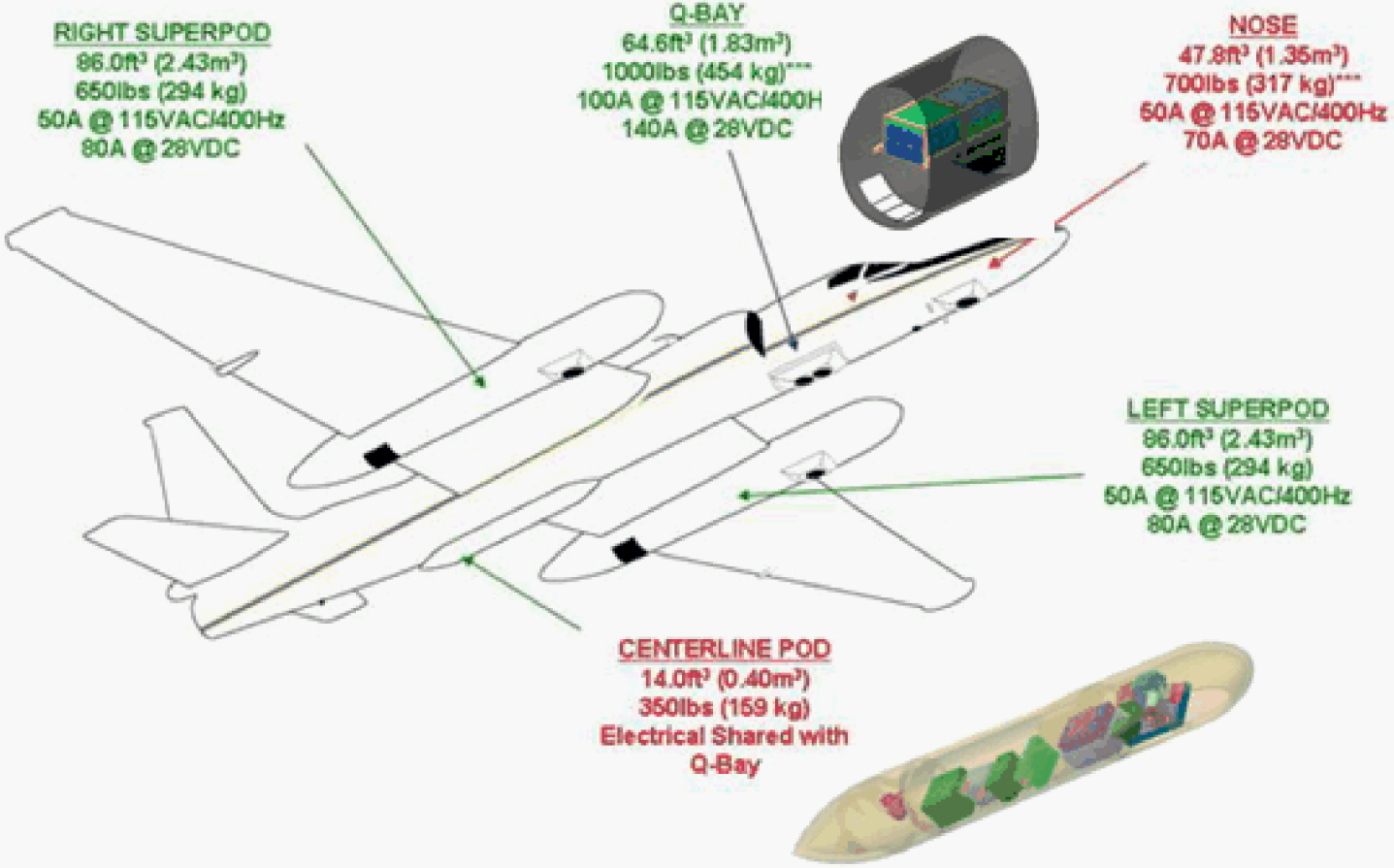
ER-2 Aircraft Installation



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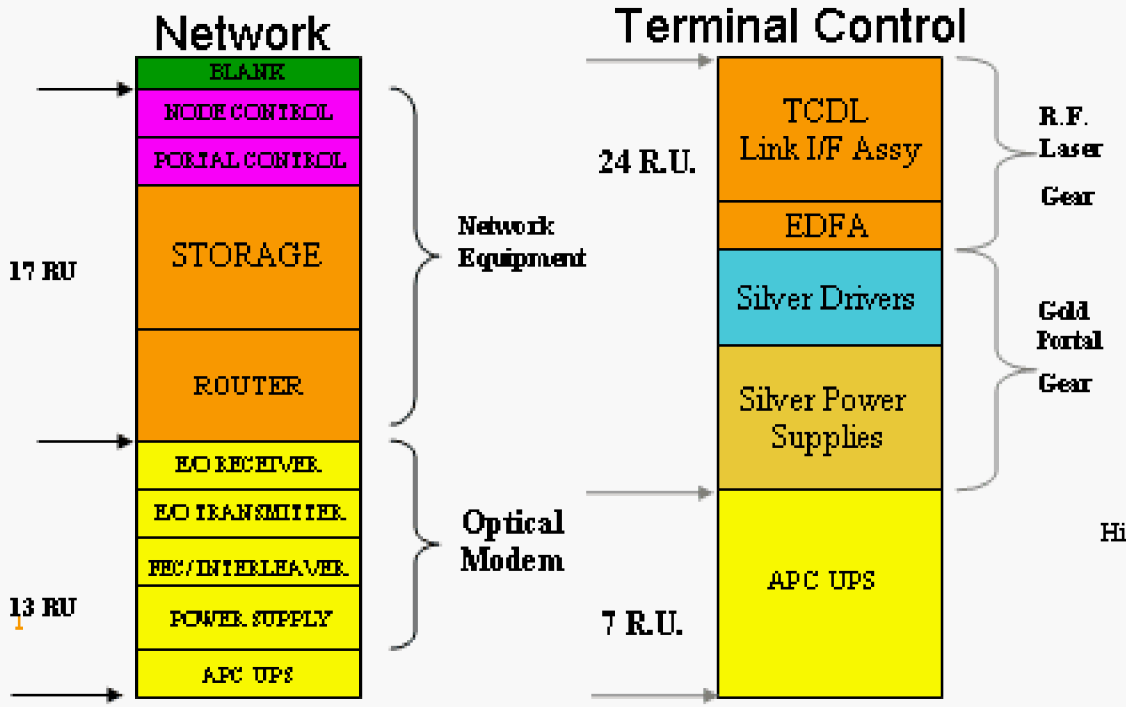
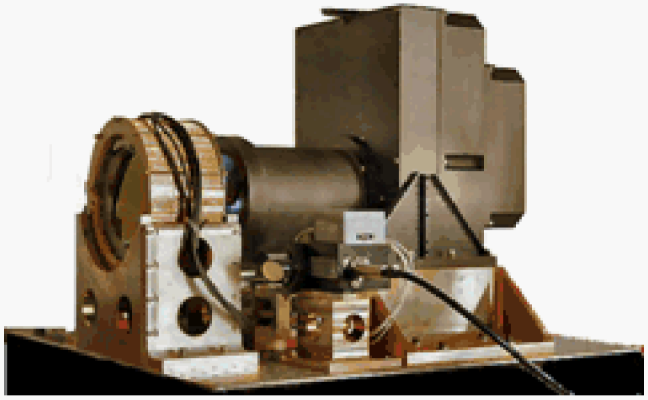
ER-2 - Physical Components



Total rack R.U.s available = 31
Total rack R.U.s used = 30
Total rack weight estimate= 770 lbs
Total rack power needs = 9.4 KW

Total rack R.U.s available = 31
Total rack R.U.s used = 31
Total rack weight estimate= 605 lbs
Total rack power needs =6.5 KW



High-gain Option

Rack Unit
Height: 54 ½ inches
Depth: 29 inches
Width: 19 inches

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Air Node 2: Rolling Aircraft Selection

NASA B 757

C-135 ACAT

C-135 Big Crow

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Optical Windows

- Surmet on USAF contract to manufacture windows
- Circular flats and associated bezel mounts
- Requirements determined by Aircraft type/location
- Design finalized once an aircraft selected
  - Thickness & Bezel mounted TBD

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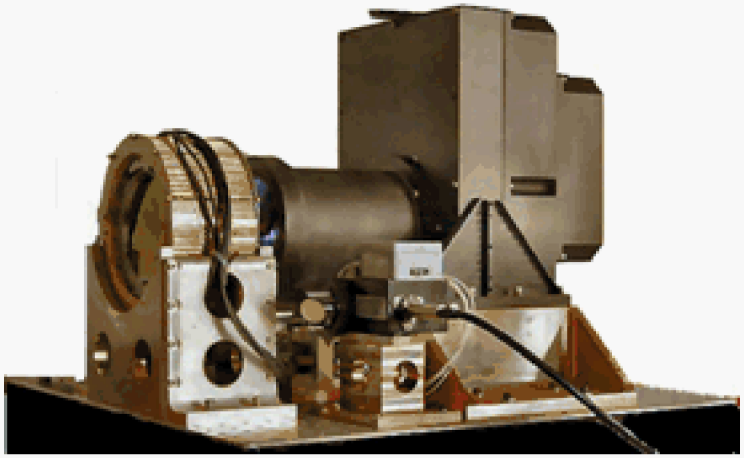
Air Node 2 Portals Antennas



Gold Portal (2 units)

Gimbal: None - PRA

FOR: +/-55degrees

Telescope: 10cm

Weight: ~90lbs

Power: 120V 60Hz

RF Portal (2 Units)

Gimbal

FOR: 2pi

Beamwidth: 8 deg

Gain 15 db

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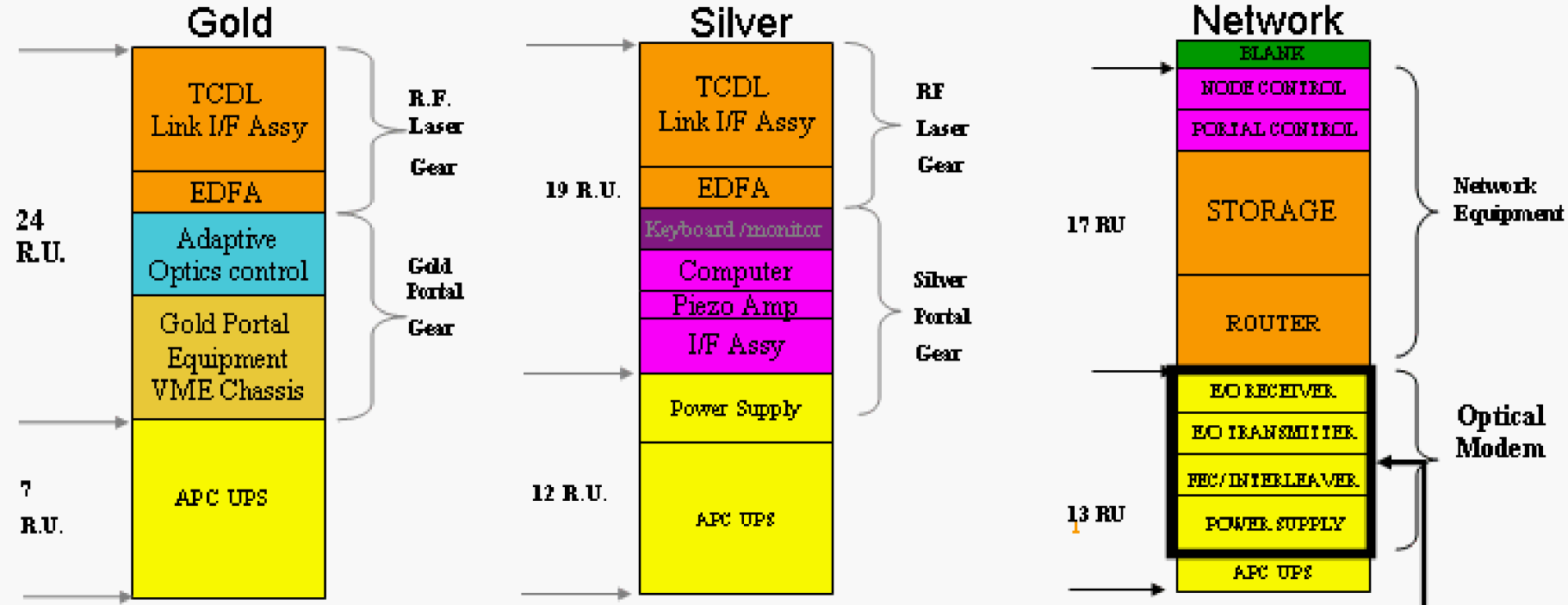
Air Node 2 System Racks



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Total rack weight estimate= 770 lbs
Total rack power needs = 9.4 KW

Rack Unit
Height: 54 ½ inches
Depth: 29 inches
Width: 19 inches

Note: 4 Rack contains second modem kit and test equipment.

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Ground Test Van (USAF)

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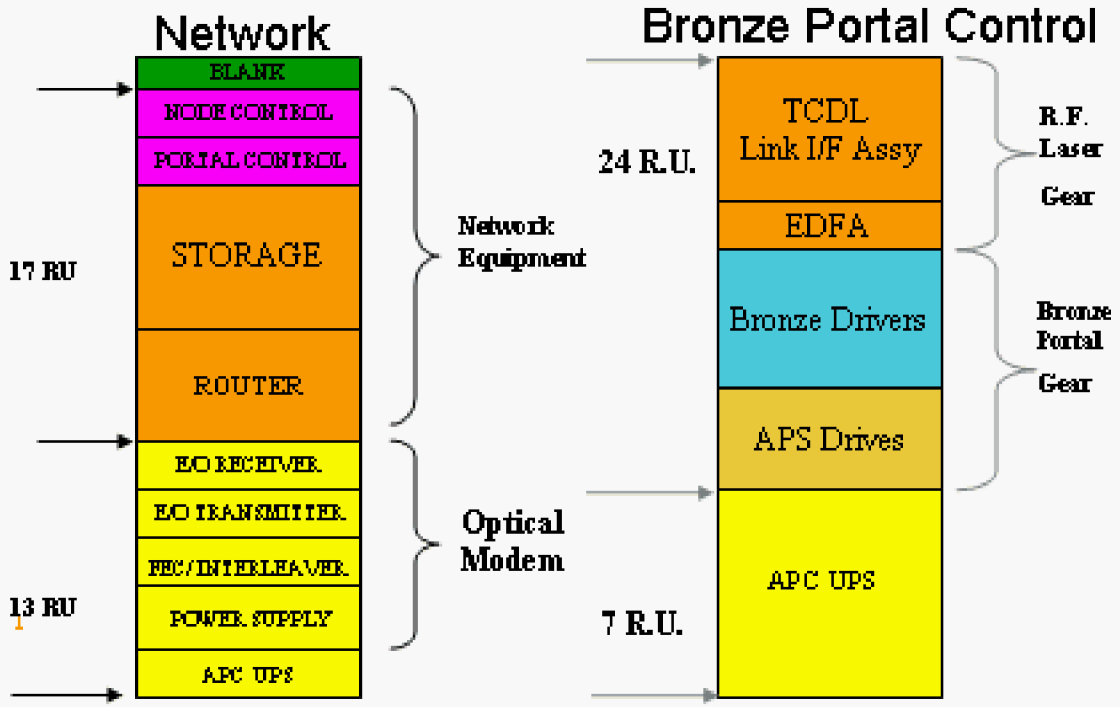
Ground Node - Physical Components



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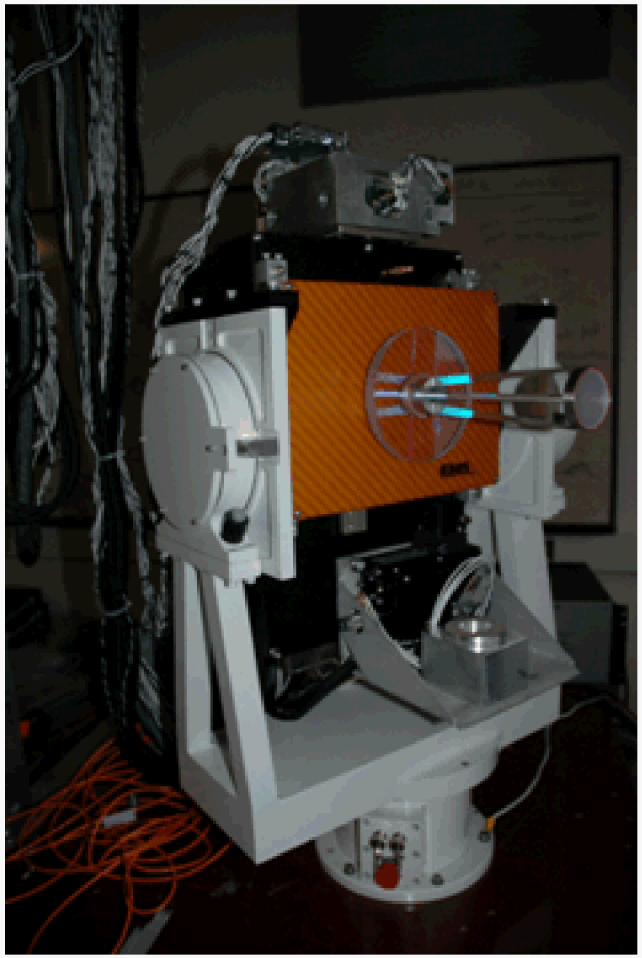

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Program Halted for Restructure

- New Program: ORCA
- New Customer
- New Platform(s)
- TRL6 Hardware @ completion

  - Stop Work Order Issued 3/9/2007
  - Submitted close-out proposal 5/18/2007
  - Close-out efforts in-process

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