EVLA / New Mexico Array:
Within and Beyond the 21-Km Radius

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National Radio Astronomy Observatory,
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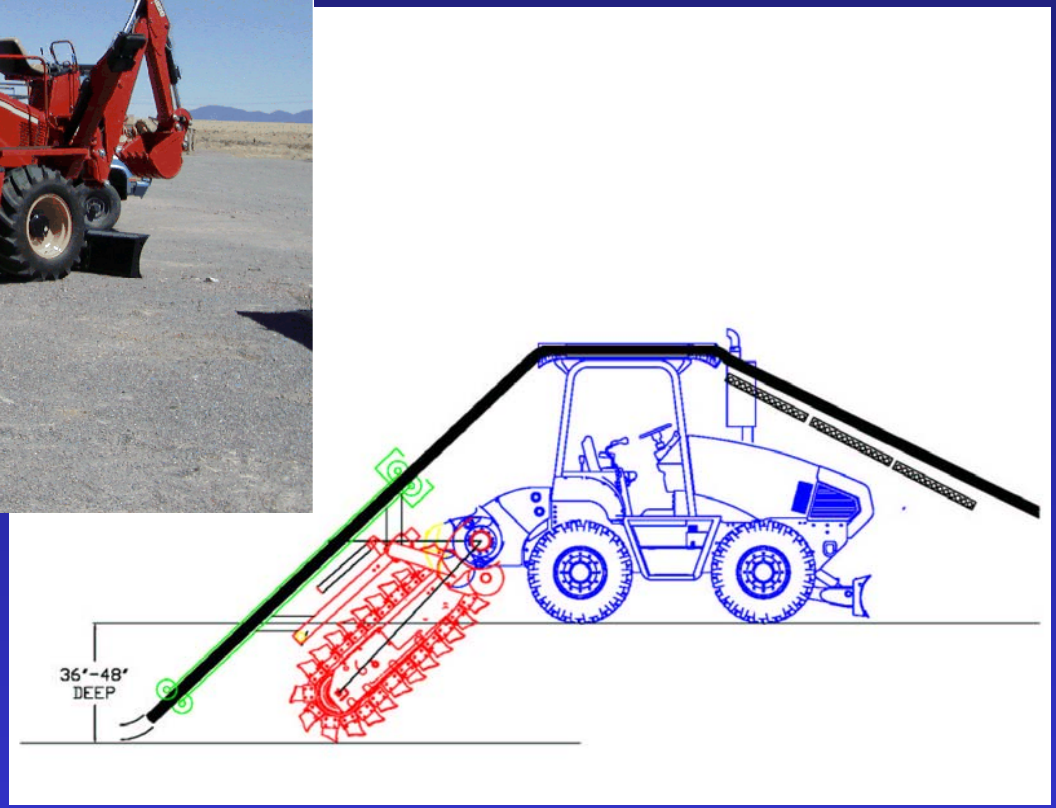
VLA - Socorro, New Mexico

Enough Fiber to Cross the United States from L.A. to D.C.

- 93.2 Km (57.9 mi) of 12 fiber cable
- 19.2 Km (11.9 mi) of 36 fiber cable
- 36.5 Km (22.7 mi) of 60 fiber cable
- 4.6 Km (2.8 mi) of 96 fiber cable
- Total trench length is 65 Km (40.4 mi)
- Total cable length is 153.5 Km (95.4 mi)
- Total fiber length is 4441 Km (2759.6 mi)
- Total delivered fiber cable cost - $330K

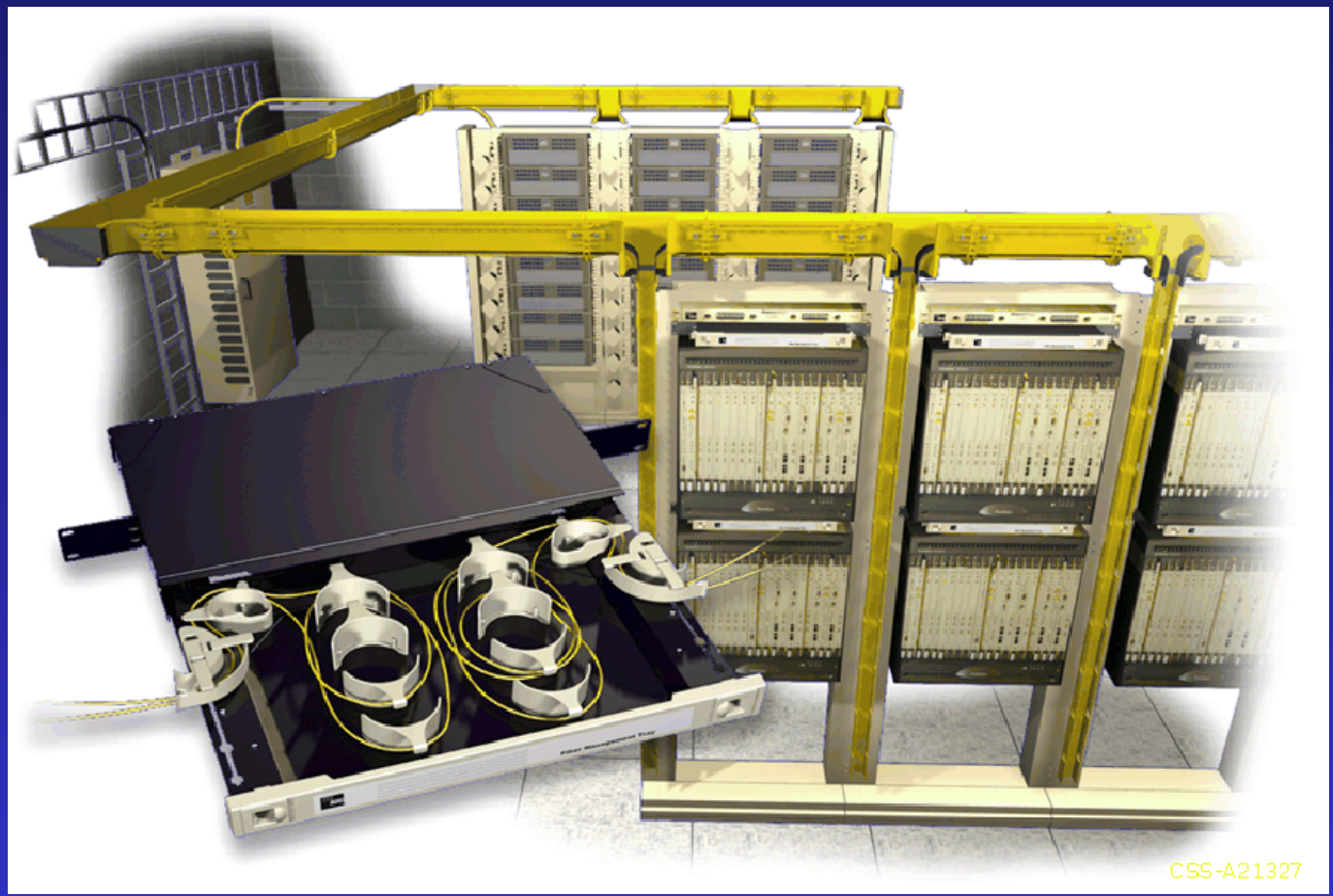
Ditch Witch



VLA West Arm Complete
22 Km of Ditch

- 6 Men 7 Months
  - $95K Labor
- $110K of Fiber
  - 34 locations (12 Fibers)
- Ditch Witch, Loader Grader - $240K

Typical Termination Room



Expanded
Very Large Array

VLA Installation

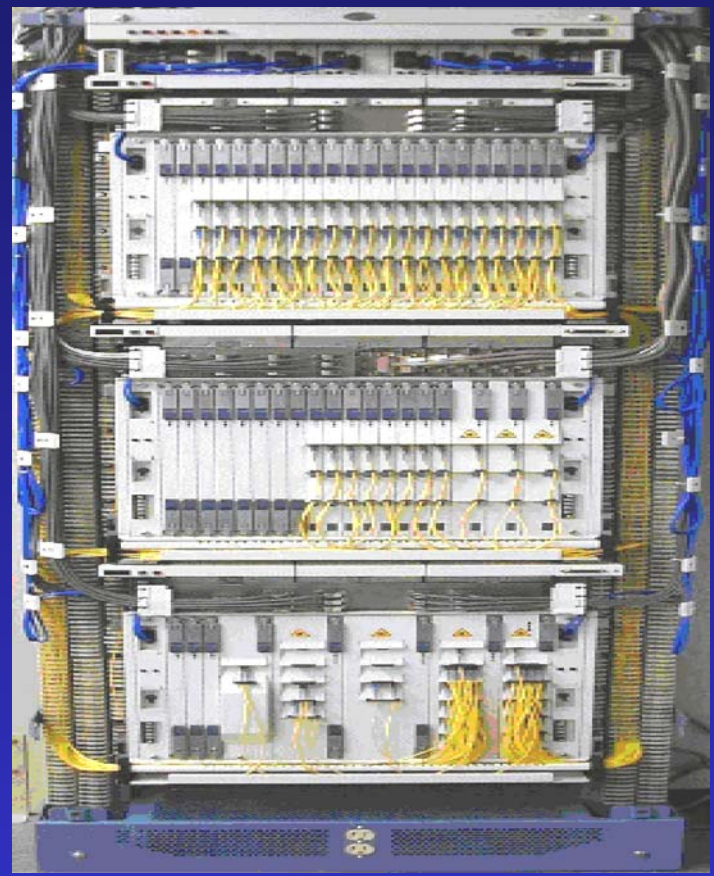
New Mexico Array

- 8 New Antennas Plus VLBA

  Pie Town and Los Alamos
- Range up to 250Km from VLA
- Will be implemented within the next 10 years
- Requires Time Synchronization

Commercial Hardware

- Compliant
  - GR-918-CORE
  - Phone company
- Reliable
  - Multiple Vendors
- Error Correction and Monitoring



Typical Optical Reach of Different Cables vs. Format

Fiber Type	Serial GbE Distance (m)	WDM 10 GbE without Compensation	WDM 10 GbE with Compensation
Multimode	**850/1300 nm**	**850/1300 nm**	**850/1300 nm**
FDDI grade 62.5	220/550	26/ -	- /300
Standard 62.5um	300/550	33/ -	- /300
Premium 62.5	500/1000	33/ -	- /300
Single-Mode	**1310/1550 nm**	**1310/1550 nm**	**1310/1550 nm**
SMF-28	5,000/ -	10,000/40,000	40,000/100,000

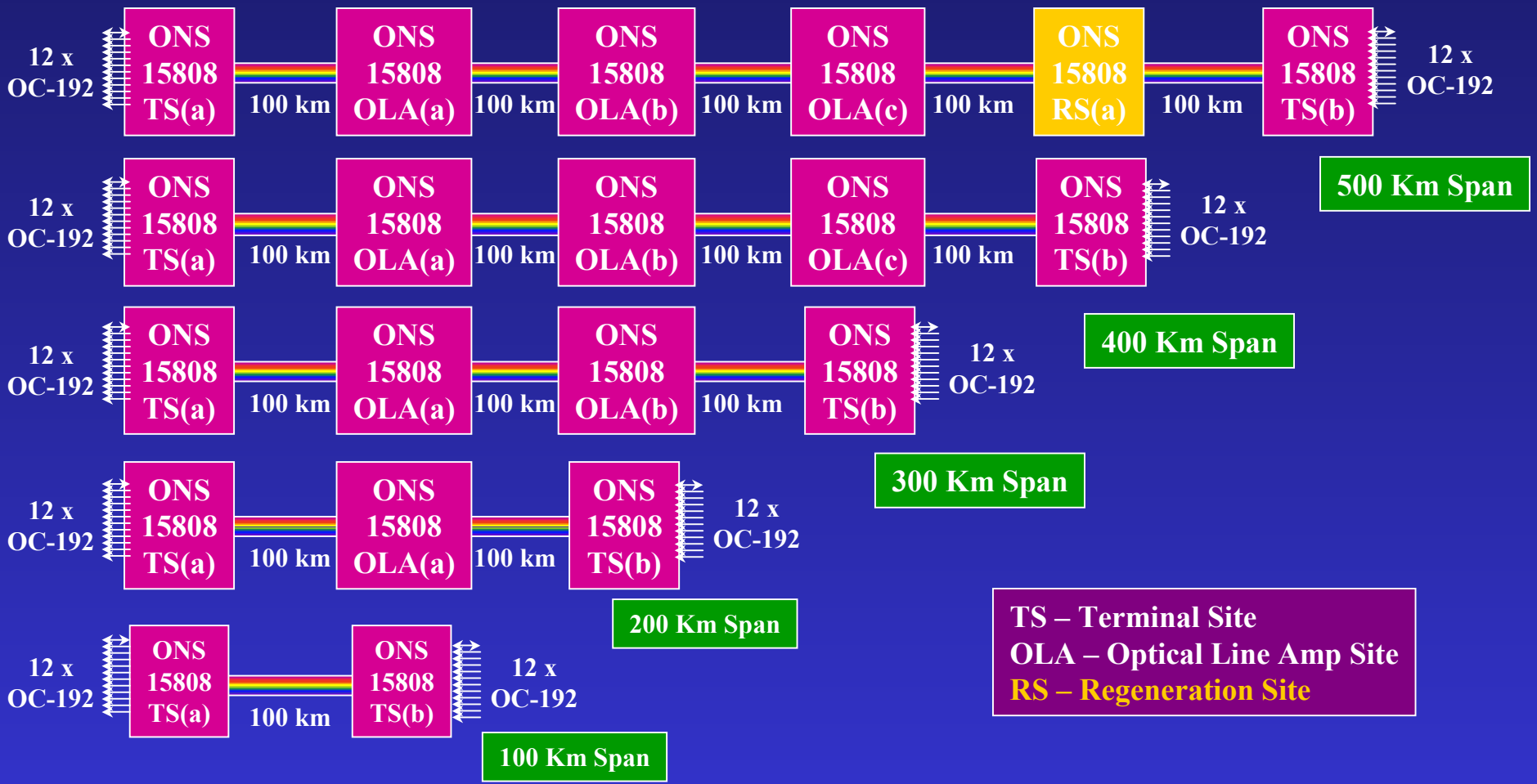
COTS 15808 Solution

Control Room Site

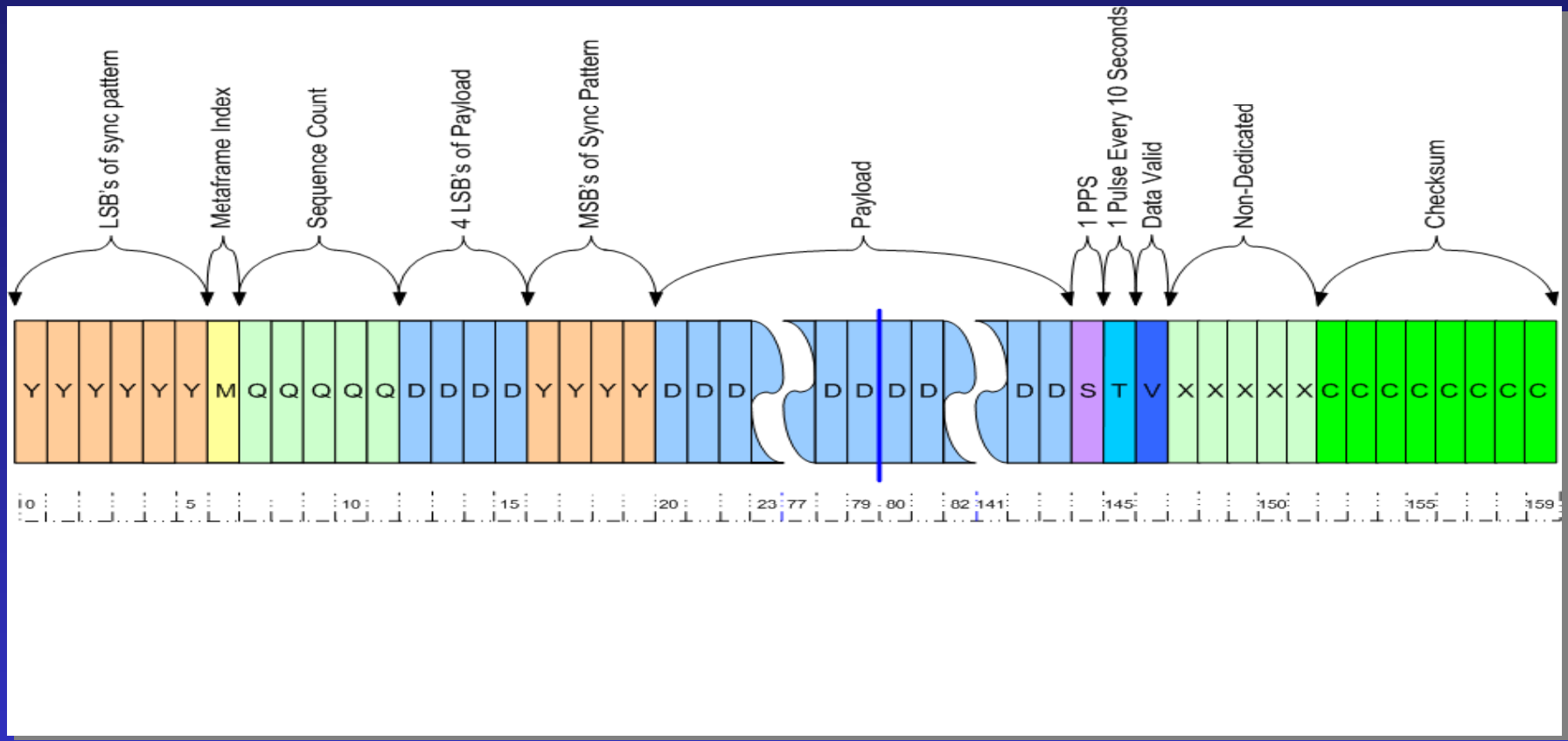
12 OC-192 Channels/Wavelengths

1 OC-192 Channel/Wavelength

Receiver Site



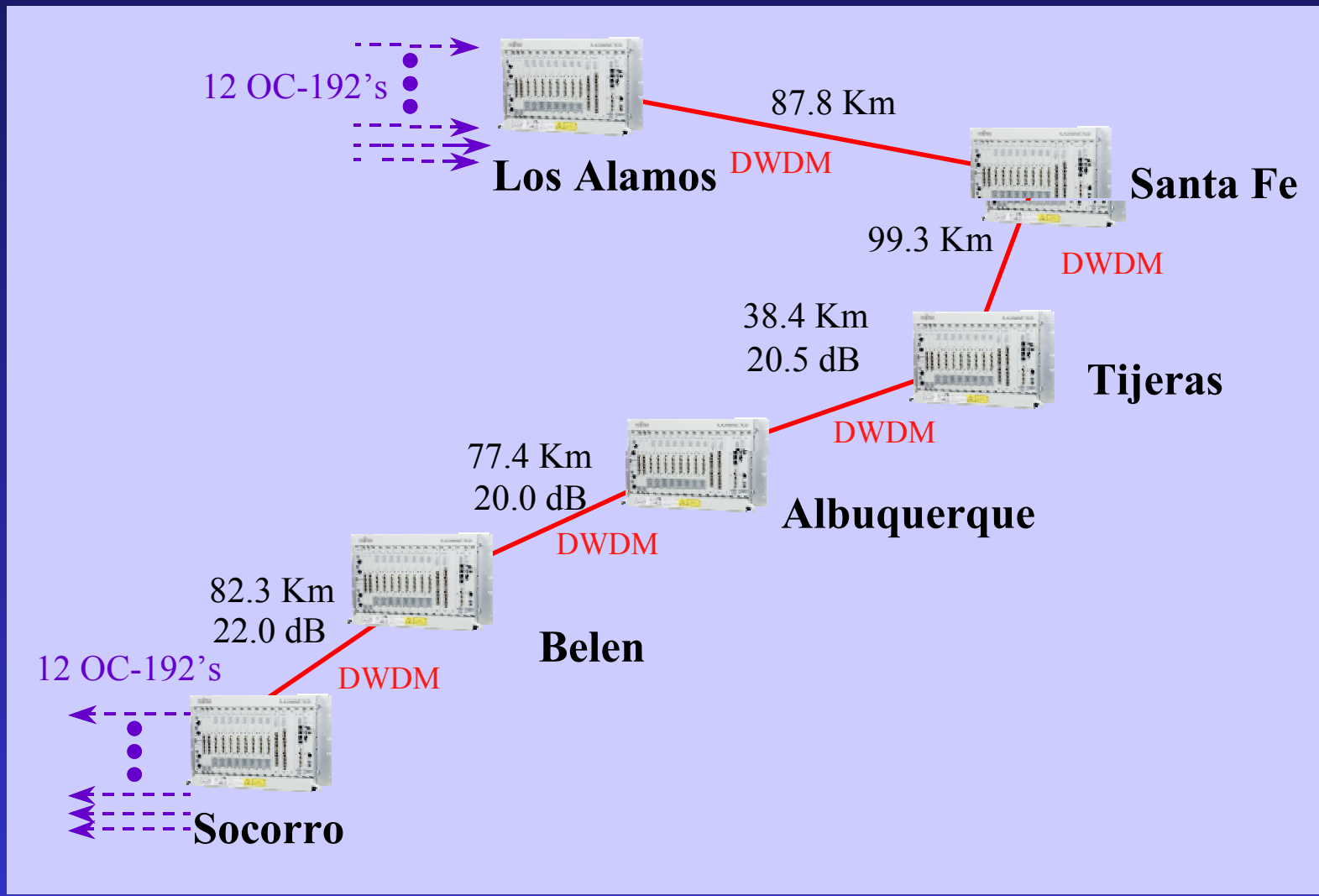
The Data Frame



Data Rate

Menu	Data Rate	Description
1	9.953 Gbps	SONET OC-192/SDH SSTM-64
2	10.313 Gbps	IEEE802.3ae
3	10.709 Gbps	ITU-T G.709

Los Alamos Path



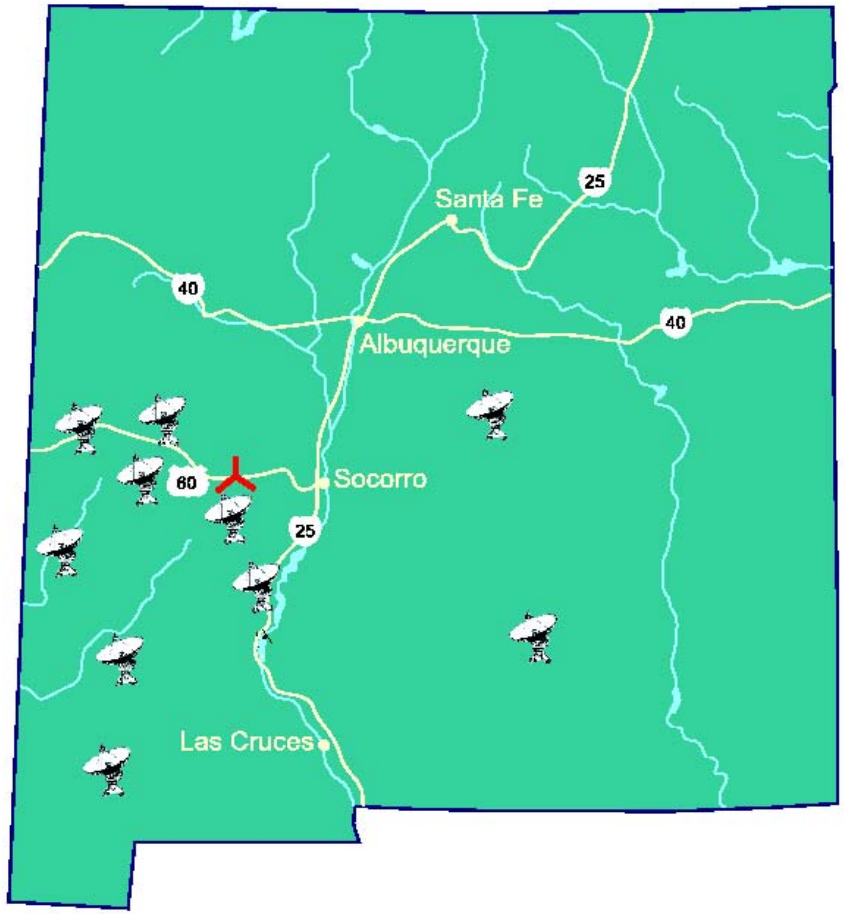
Commercial Bandwidth Provider

- First Los Alamos bid
  - 16 - OC192 links and ten years of service
    - Prepayment of $30 Million
    - Plus $45K per mile for fiber installation
- Fourth Los Alamos bid
  - Single direction OC192 links
    - $0.5M per year for ten years ($5M)
    - Plus $35K per mile for fiber installation

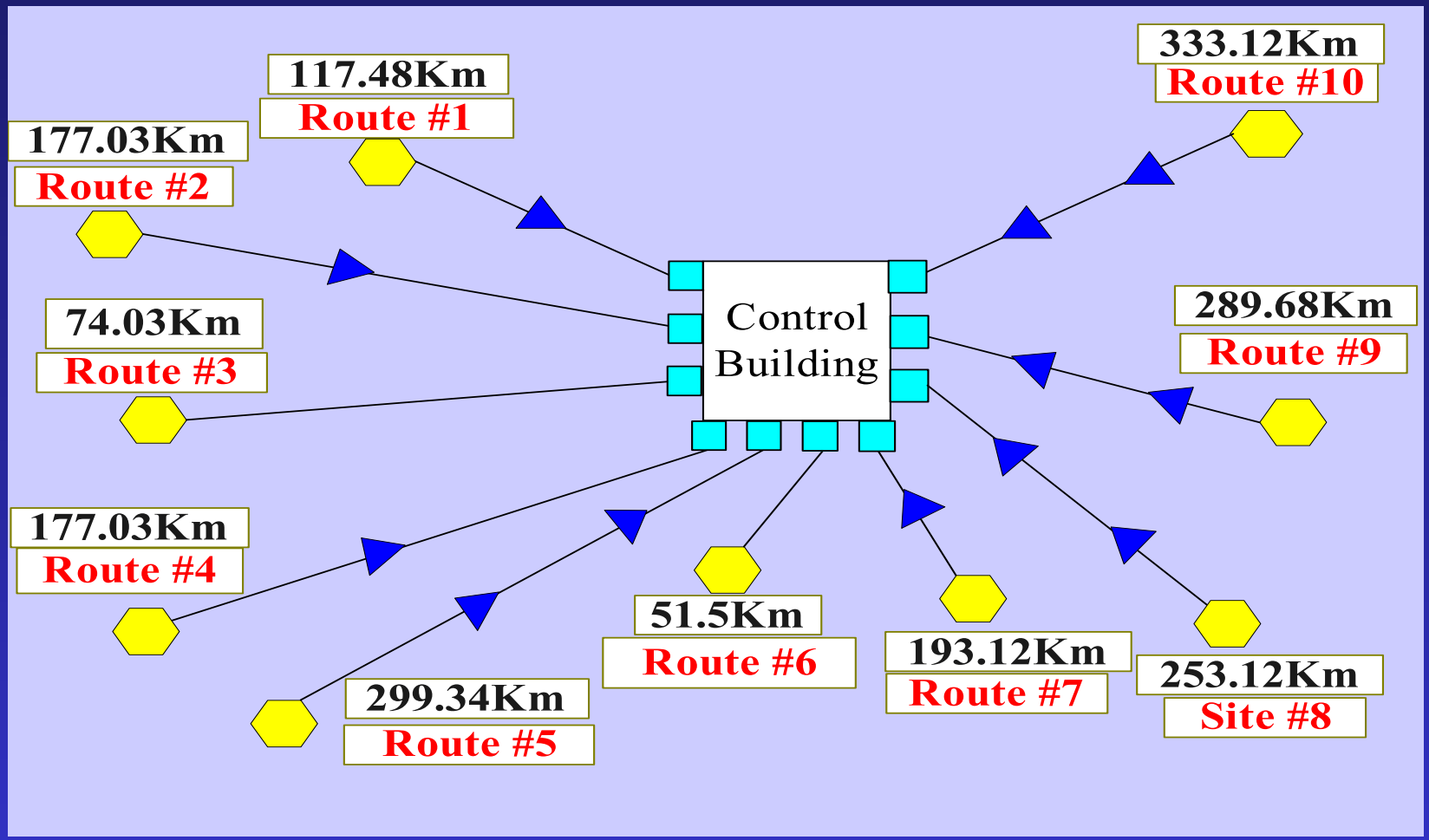
Dark Fiber Solution

- Lease dark fiber from small local companies
- Obtain access to vaults and stations
- NRAO to provide all equipment including
  - Power Supplies, Air Handlers, EDFAs

NM Array Version 2



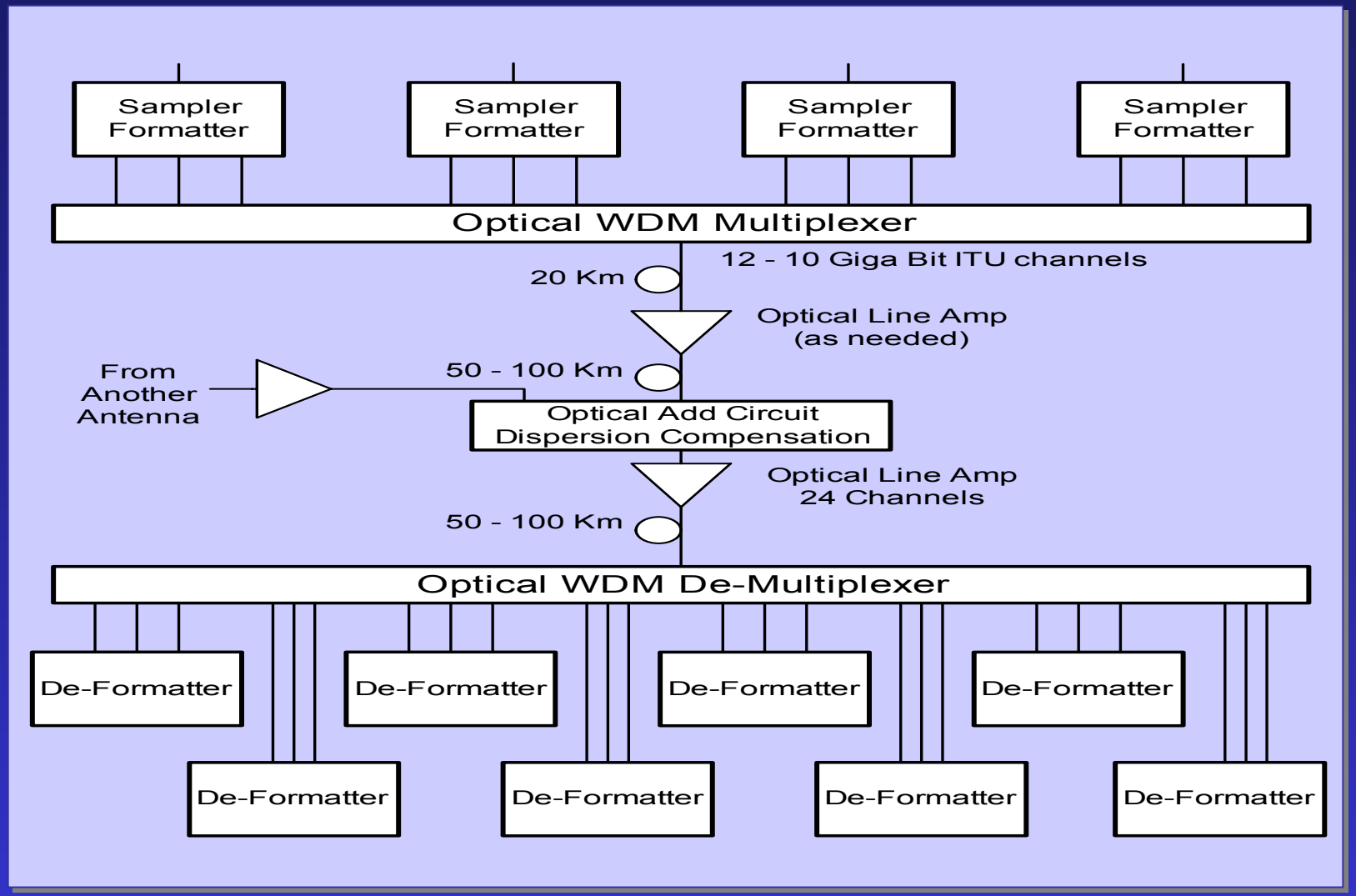
Proposed Fiber Distances



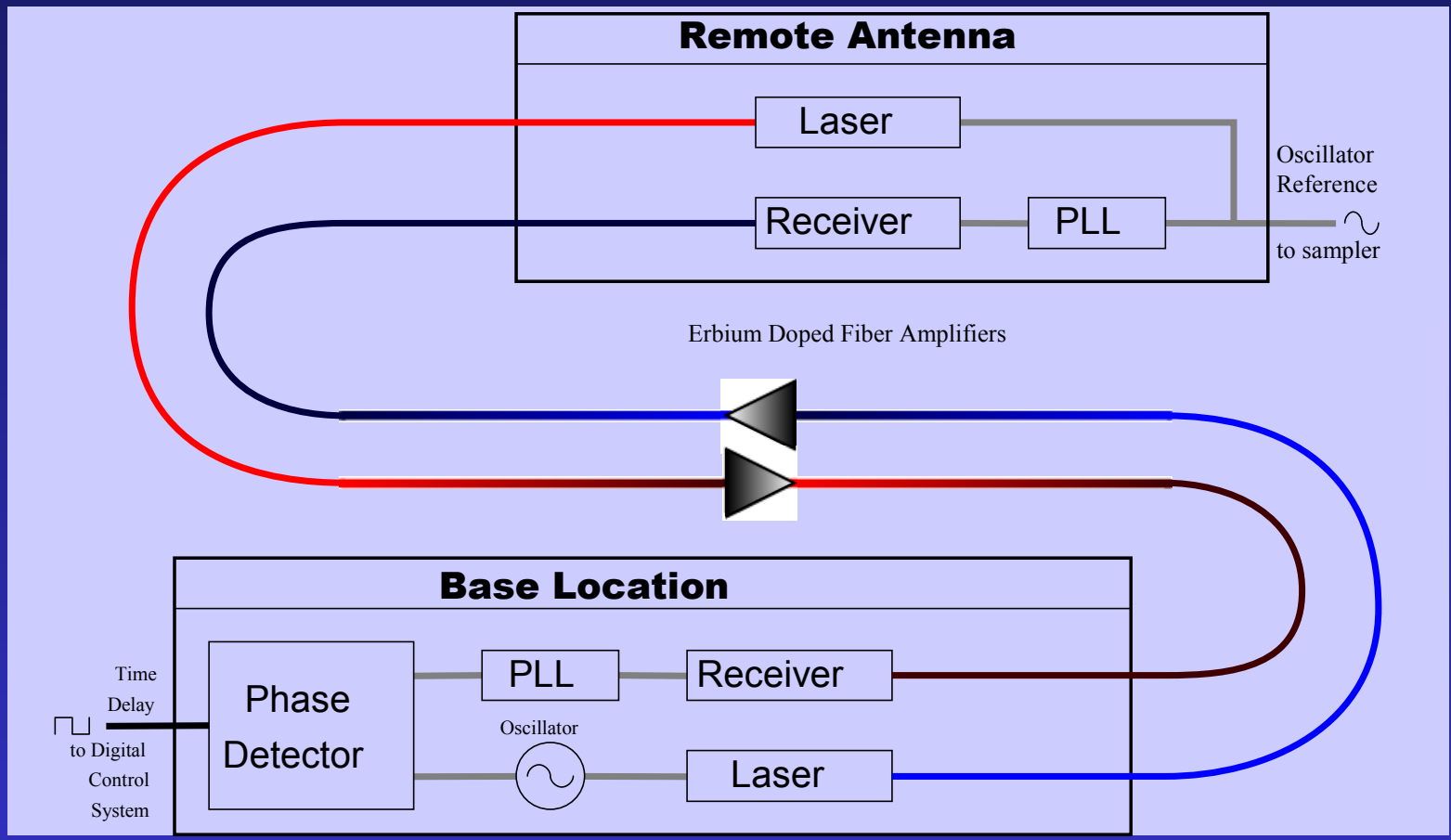
NRAO Solution

- NM Array Dark Fiber Network
  - $698K per year for ten links (~1800 Km)
- NM Array Hardware Estimate (EVLA)
  - $5M for ten sites including Vault Hardware
- Los Alamos Link
  - $100K for ten years = $1M
  - Hardware and maintenance $0.7M
  - NRAO solution $1.7M versus $5M

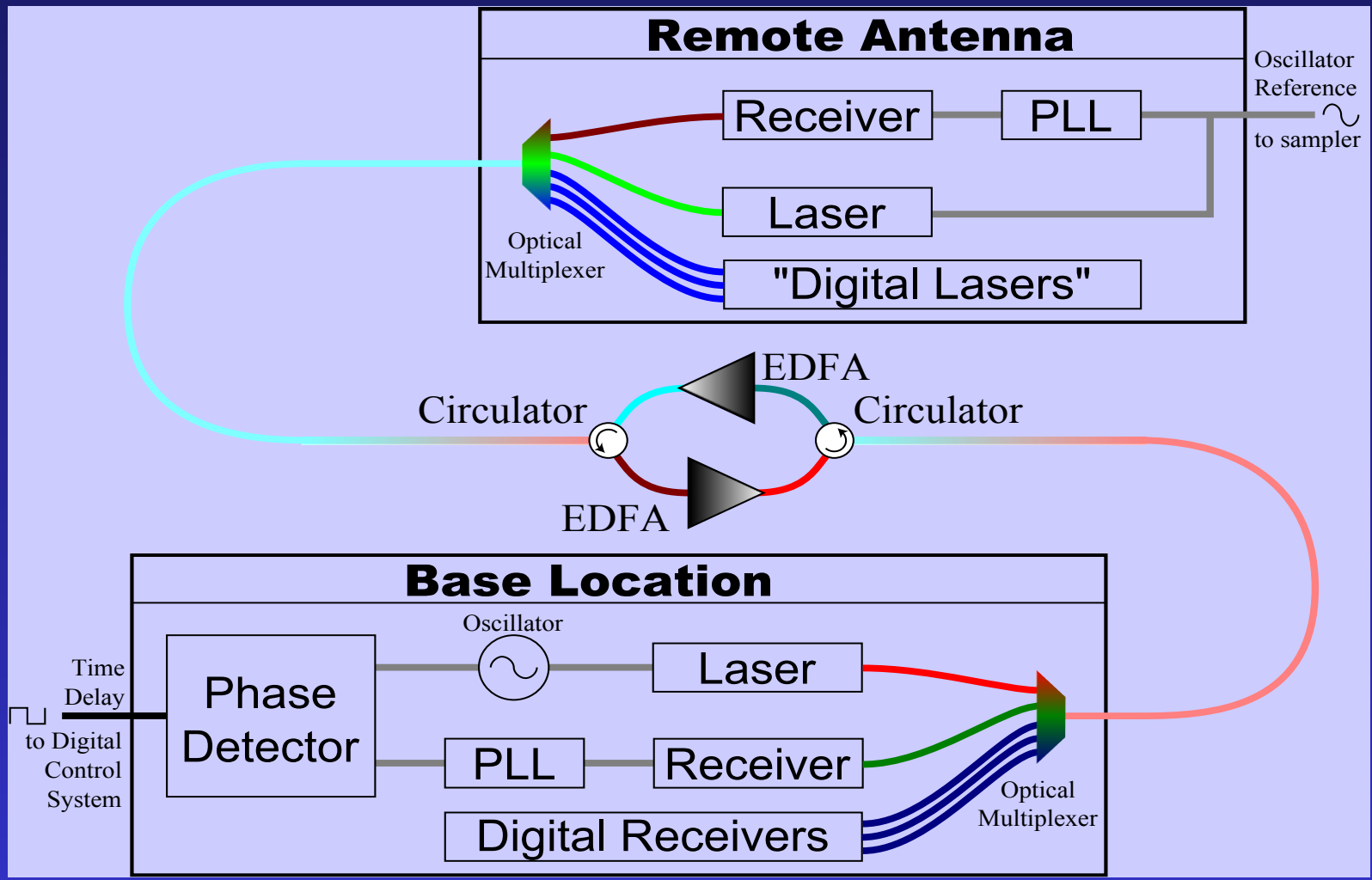
NM Array Block Diagram



Duplex Communication

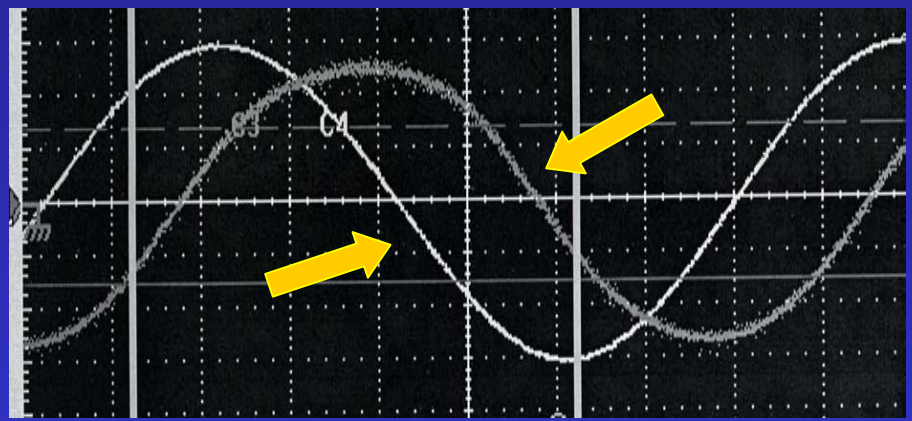


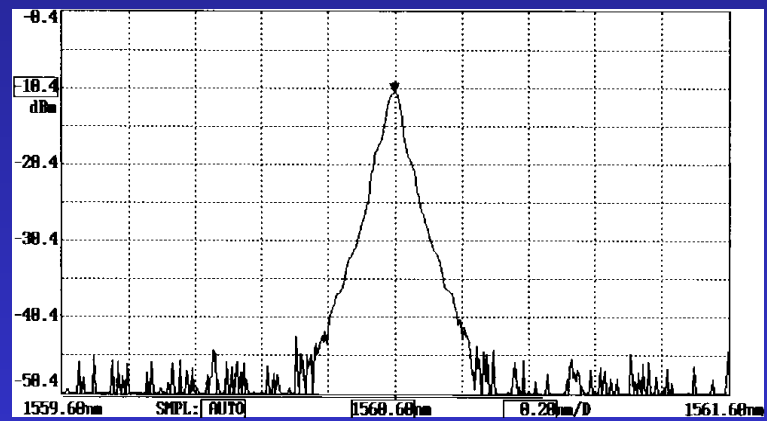
Duplex Design Overview



Single Fiber Results

- Full duplex Proof-of-Concept testing provided promising results:
  - 10 Gigabit Digital Signals and 512 MHz Analog
  - Acceptable isolation between channels
  - Apparent stability within 8-10 picoseconds





A Typical Dark Fiber Designer