

# Lockheed Martin/CSOC Space Link Extension (SLE) Test bed Status

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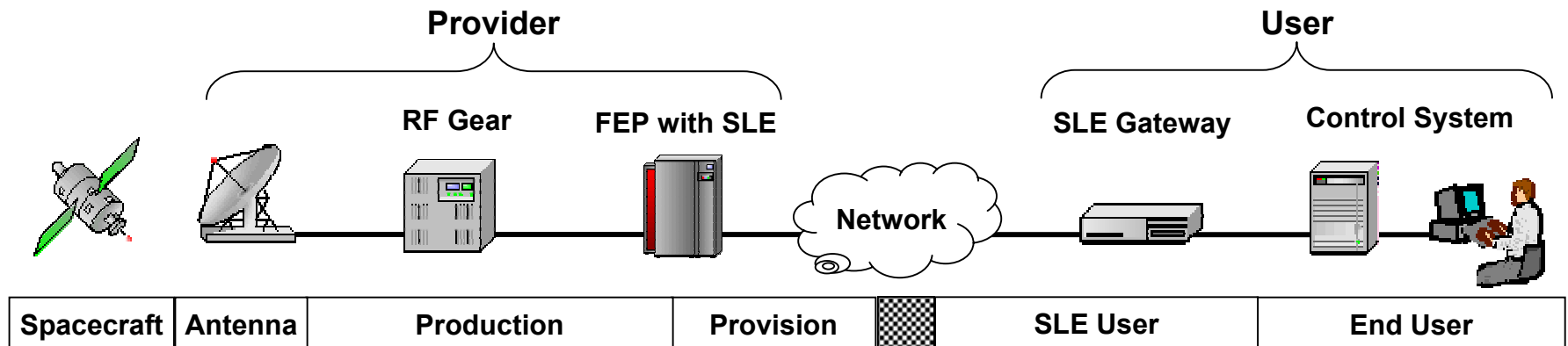
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- Overview of SLE services/definitions
- Test bed introduction
- 2002 activities
  - Test bed components
  - Test results
- 2003 activities
  - Test bed components
  - Planned tests
  - Remaining tasks
- Potential follow-on activities

# SLE Transfer Services Overview



- **RAF (R-AF)** – Return All Frames service
- **RCF (R-CF)** – Return Channel Frames service
- **CLTU (F-CLTU)** – Forward Command Link Transmission Unit service
- **Provider** – acquires space link, sends data between user and spacecraft (Ground Station)
- **Production** – performs space link processing (bit synchronization, error correction, time-stamping, etc)
- **Provision** – maintains SLE connection with the User (acts as the server)
- **SLE User** – establishes SLE connection to the Provider (acts as the client)
- **End User** – receives telemetry and issues commands (Control Center)



# SLE Test bed Goals and Schedule

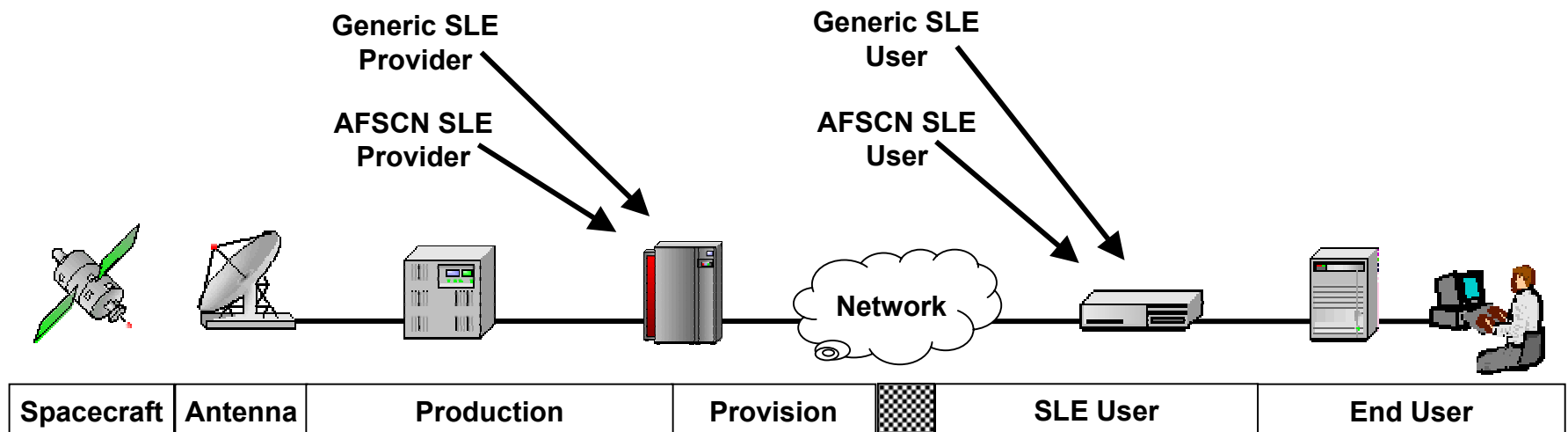


- FY 2002 Goals
  - Build-up knowledge/experience base
  - Deploy infrastructure to Wallops Flight Facility (WFF)
  - Verify test bed infrastructure with simulated data flows
- FY 2003 Goals
  - Demonstrate the application of SLE to the NASA Ground Network (GN) and Space Network (SN) through tests with NASA satellites
  - Demonstrate interoperability with the Air Force Satellite Control Network (AFSCN) by supporting DoD satellite contacts

ID	Task Name	Start	End	2002			2003	
				Q2	Q3	Q4	Q1	Q2
1	Lab build-up, SLE development, integration, and test	4/1/2002	9/20/2002					
2	Deploy SLE provider to WFF 5.4m antenna station	9/2/2002	9/27/2002					
3	Planning for NOAA installation and for tests with satellites	10/1/2002	5/1/2003					
4	SLE tests with satellites at WFF 5.4m station	3/10/2003	5/30/2003					
5	Deploy SLE provider to NOAA WCDAS	5/1/2003	5/20/2003					
6	SLE tests with satellites at WCDAS	5/20/2003	6/31/2003					

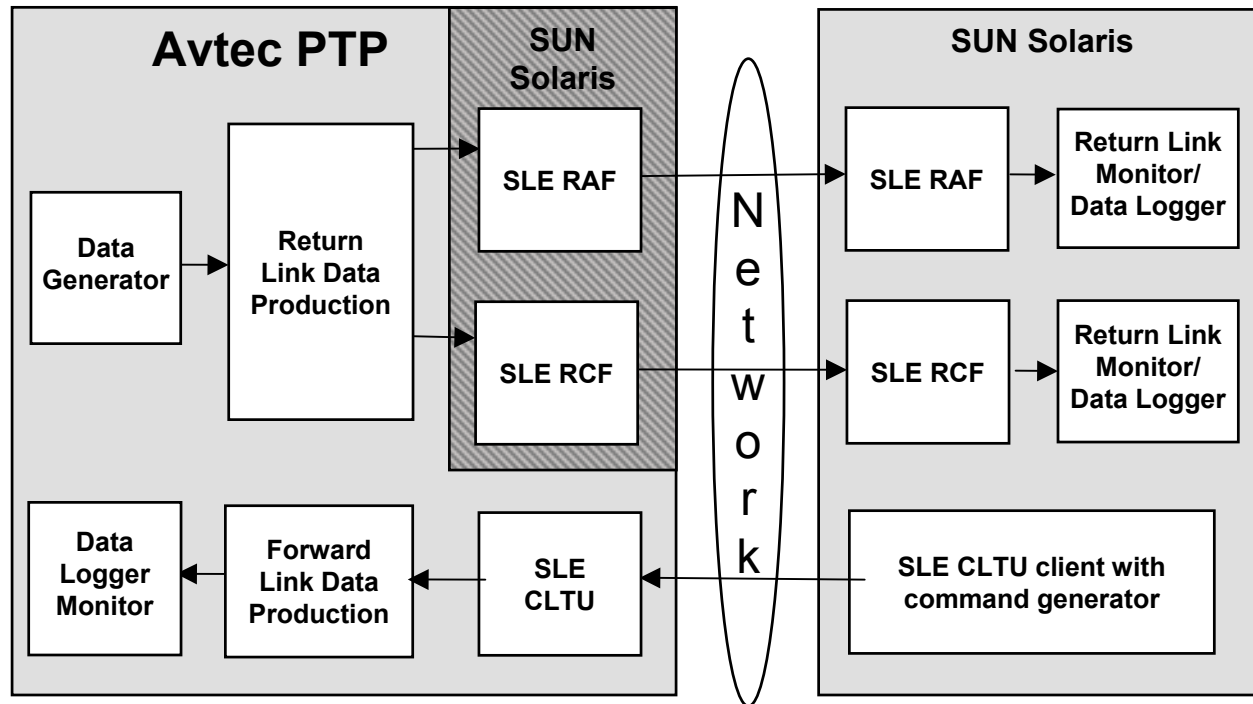
# SLE Test bed Overview

- Two SLE systems (provider and user) were integrated in the LM SLE lab
  - A “generic” system that demonstrates SLE for missions with CCSDS compliant or TDM space links
  - An AFSCN prototype system that demonstrates SLE for missions with an unframed space link. It was developed by Global Science and Technology (GST)



# Generic SLE System (2002)

- COTS Telemetry and Command Processor with SLE CLTU provider service
- Sun workstation hosting RAF and RCF provision
- Sun workstation hosting SLE user tools

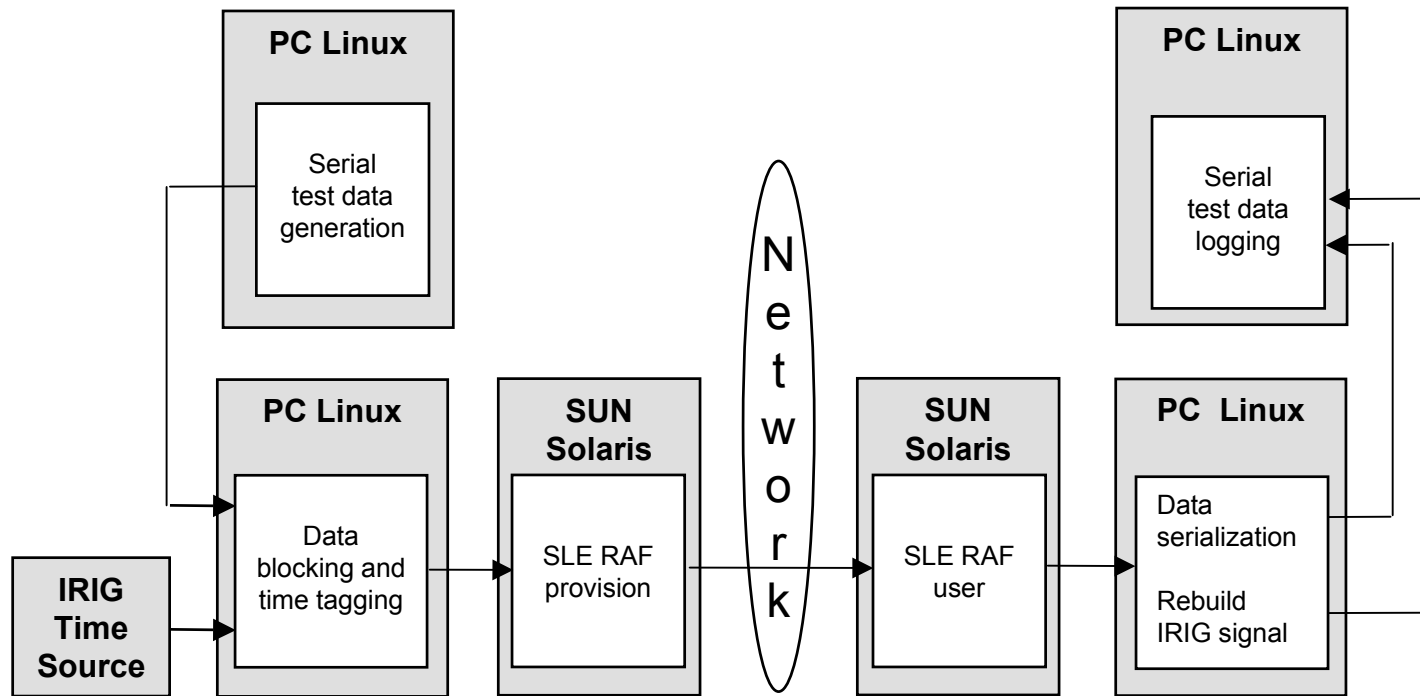


Spacecraft	Antenna	Production	Provision		SLE User	End User
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# AFSCN SLE System (2002)



- 4 PC workstations with serial and IRIG adapter cards to perform specialized data production
- 2 Sun workstations hosting RAF provision and RAF user

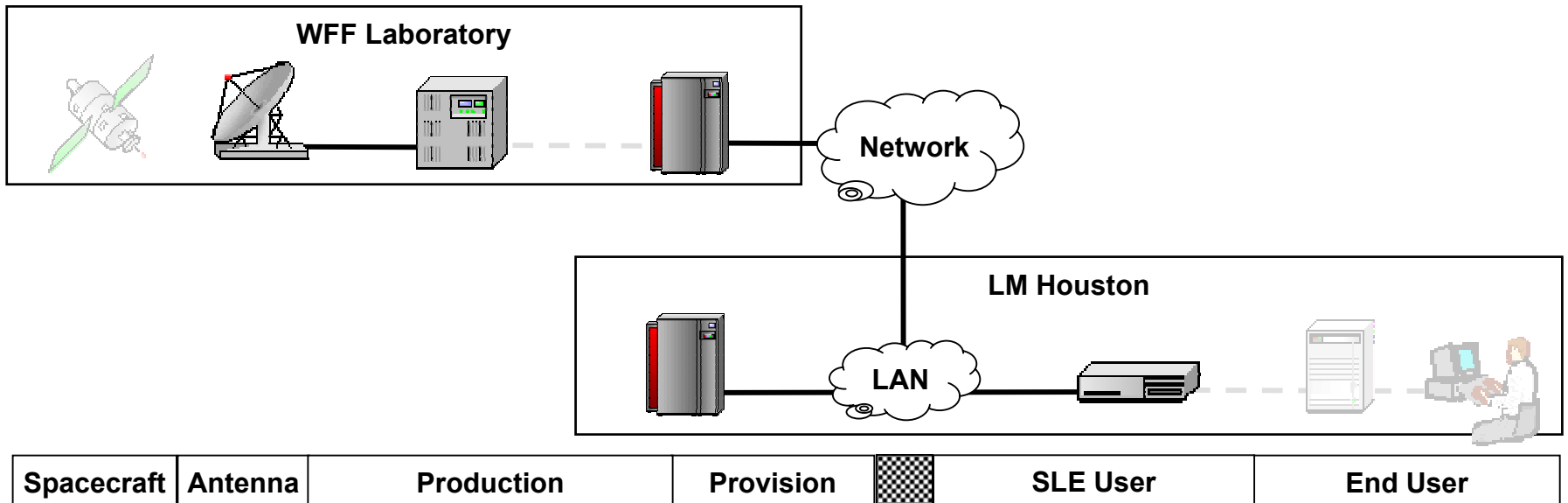


Spacecraft	Antenna	Production	Provision		SLE User	End User
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# SLE Test bed Sites (2002)

- Provider system and user system installed at LM SLE lab in Houston, TX in 7/2002
- Provider system installed at the WFF Microwave Telemetry Test Laboratory at Wallops Island, VA in 9/2002



- Generic SLE System
  - Successful testing of basic SLE operations
  - RAF and RCF tested up to 3 Mbps
  - CLTU tested to 2 Mbps
  - Concurrent RAF, RCF, and CLTU testing was successful at rates of 192 Kbps, 21 Kbps, and 200 Kbps, respectively
  - Above performance is dependent on the platform used, more powerful versions are available, but the expense was not justified for the purpose of this task
  
- AFSCN SLE System
  - System tested up to 512 Kbps in LAN, up to 256 Kbps across WAN
  - Failures at higher rates may be attributed to loss of time-data correlation, not necessarily a failure in the SLE applications

# Lessons Learned (2002)

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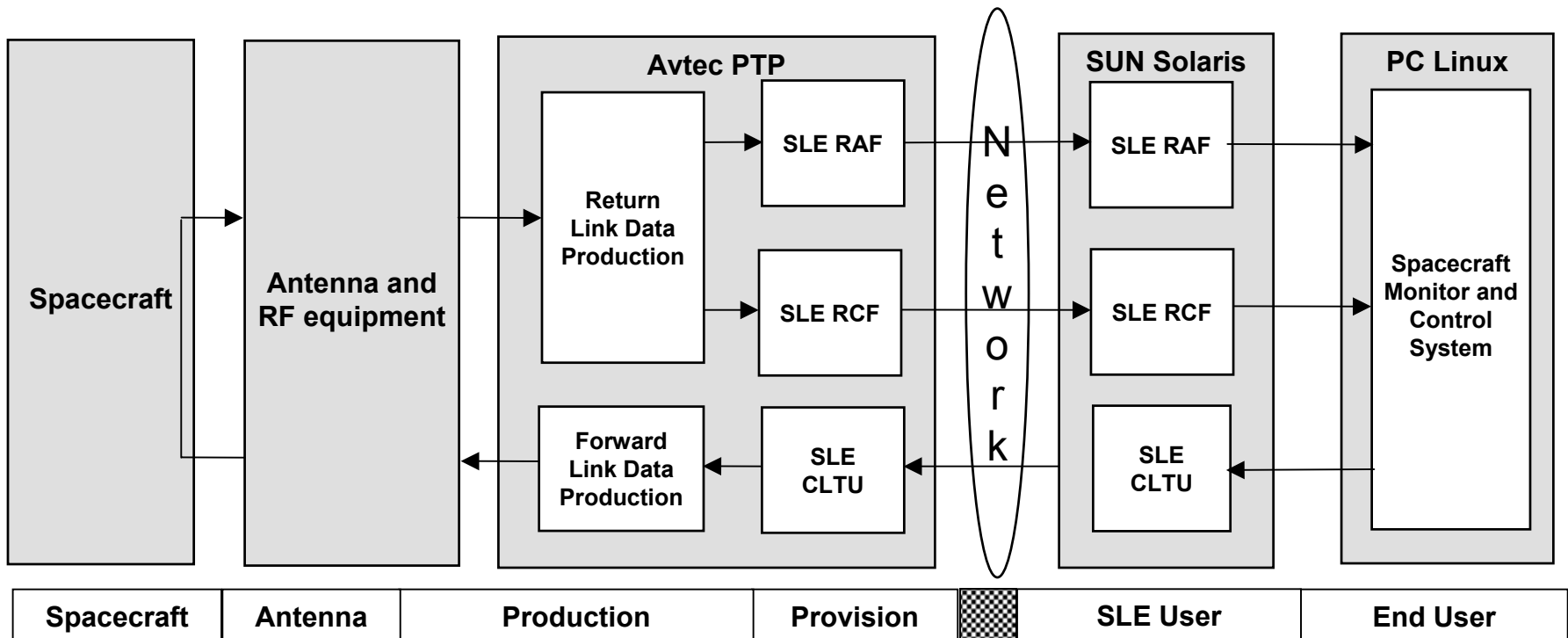


- Receiving the SLE API source from JPL produced a substantial savings in time and effort
- To use the API requires one of the following:
  - The COTS OSS ASN.1 tool
  - Another COTS ASN.1 tool and re-writing of the interface
  - An in-house implementation of a subset of ASN.1 and re-writing of the interface
- The JPL API source did not contain several pieces of software that ideally would have been provided as an example
- GST SLE implementation saved significant time by providing samples to fill those gaps
- JPL SLE CLTU client application and CLTU provider simulator accelerated testing efforts and proved to be useful for troubleshooting
- Use of network monitoring tools and memory leak analysis tools were helpful in seeing what SLE was doing

# Generic SLE System (2003)

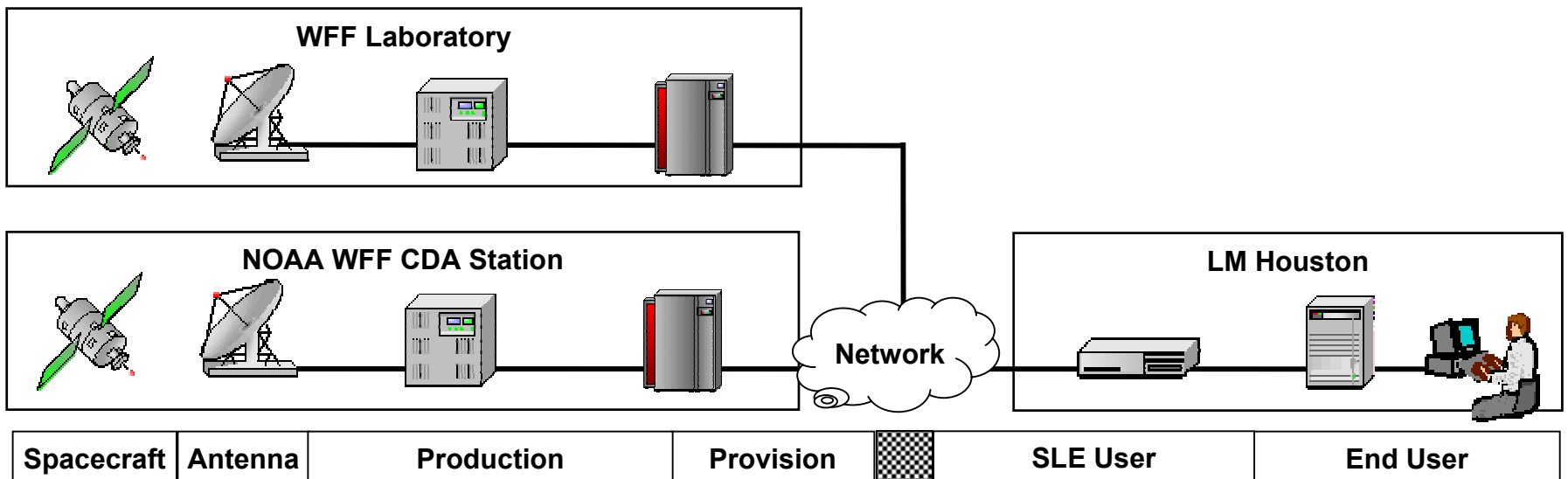


- All SLE provision is performed by the COTS processor
- Replaced simple data monitors with a spacecraft monitor and control system
- Testing with satellites will connect the forward and return services



# SLE Test bed Sites (2003)

- Changes from 2002
  - SLE user system interfaces to a spacecraft monitor and control system
  - Provider system at the LM SLE lab is moved to the NOAA WFF CDA Station at Wallops Island, VA in 5/2003
  - Connections are made at both ground stations between the SLE systems and the ground station equipment
  - Satellite contacts are scheduled



# Satellite Tests (2003)



- Tests with the WIRE and COBE satellites will be conducted between the LM SLE Test lab and the WFF and WCDAS test stations. RAF, RCF, and CLTU services will be demonstrated.
- The WFF test station will support tests conducted by the AFSCN's CERES control center with a DoD TACO satellite. This test will demonstrate the transfer of unframed telemetry via SLE RAF.
  - WFF equipment can not support the TACO forward command modulation.

Test	Satellite	Ground Station	Control Center	Telemetry	Command
1	WIRE	WFF 5.4m	LM Houston	Avtec SLE RAF/RCF	Avtec SLE CLTU
2	COBE	WFF 5.4m	LM Houston	Avtec SLE RAF/RCF	Avtec SLE CLTU
3	DoD TACO #5	WFF 5.4m	AFSCN CERES	GST SLE RAF	None
4	WIRE	NOAA CDA	LM Houston	Avtec SLE RAF/RCF	Avtec SLE CLTU
5	COBE	NOAA CDA	LM Houston	Avtec SLE RAF/RCF	Avtec SLE CLTU

# Remaining Tasks (2003)

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- Deploy provider system to NOAA WFF CDA Station
- Conduct SLE testing with satellites (as described on previous page)
- Prototype SLE management
  - For more information see “Lockheed Martin/CSOC SLE Management Service Request Prototype” by Andy Schreckenghost/Steve Autry
- Coordinate/cooperate with various groups regarding SLE user functions
  - GMSEC – demonstrate SLE to GSFC missions & operators
  - CSOC JPL – develop SLE experience in support of DSN operations
  - NASA GSFC Code S – address SLE support for legacy missions

# Potential Follow-on Activities

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- Conduct tests between the DoD TACO satellite and CERES via the NOAA WCDAS
- Add and test CLTU commanding of a DoD TACO satellite via the NOAA WCDAS
- Investigate application of SLE to SSP and ISS
  - For more information see “Proposal for the Application of CCSDS Space Link Extension to NASA Human Space Flight Missions” by Larry Muzny/Jeff Boxell