Space Systems Company

Highlights

LOCKHEED MARTIN We never forget who we're working for®

Spring 2007





Connecting, Protecting, Exploring

Last summer, Lockheed Martin Space Systems Company staged 50th anniversary celebrations in our two largest locations: Denver, Colorado, and Sunnyvale, California. Thousands of employees and retirees joined us to remember the

historic milestones that opened the doors to the "final frontier," and to get a glimpse of some of the work we are doing to help our customers forge the future.

In honor of the occasion, we distributed a souvenir video with a title that summarized a half century of pioneering accomplishments in just three words: Connecting, Protecting, and Exploring. This proud tradition of service to our customers and to our country continued unabated throughout 2006, as illustrated in this annual retrospective.

In this edition of Highlights, you'll see how we connected consumers with communications satellites, protected our warfighters with classified systems and advanced defensive missiles, and explored the universe as never before. With the Hubble Space Telescope, astronomers were able to confirm that planets form from disks around other stars. Our Stardust spacecraft returned dust particles retrieved from a comet. We launched a nine-year mission to Pluto, and began looking at Mars in unprecedented detail.

We are honored to play such a critical role, not only in the preservation of freedom but also in humankind's relentless quest to discover the unknown. As we look forward to our next 50 years, it is with tremendous excitement, insatiable curiosity, and an unwavering commitment to continued mission success.

Raising the bar to the next level demands increased focus on operational excellence and partnering with the best minds in the industry. We are improving our internal processes and nurturing a culture of inclusion, collaboration, and opportunity. These efforts prompted Business Week to rank Lockheed Martin #2 on its listing of the "50 Best Places to Launch a Career."

On behalf of the 18,000 dedicated and talented employees of Space Systems Company, my deepest thanks to you, our valued customers, for trusting us with some of your toughest challenges. Please enjoy this year's edition of Highlights.

John M. Magne

Joanne Maguire U Executive Vice President Lockheed Martin Space Systems Company

LOCKHEED MARTIN

TABLE OF CONTENTS

Human Space Flight	3
Military Space	6
Surveillance & Navigation Systems	8
Sensing & Exploration Systems	10
Laser Radar Systems	11
Commercial Space	16
Strategic Missile Programs	18
Missile Defense Systems	20
Launch Vehicles & Services	24
Space Science & Technology Development	26
Special Programs	28





HUMAN SPACE FLIGHT

HIGHLIGHT: Exploring

NASA's first crewed spacecraft procurement in three decades – Orion – advances the nation's Vision for Space Exploration.

In August 2006, following an almost three-year competition, NASA chose the Lockheed Martin team to design and build **Orion**, the nation's next-generation human space flight system. Orion marks a major step forward in America's Vision for Space Exploration, taking astronauts to the Moon, Mars, and beyond. Orion will succeed the space shuttle as NASA's primary vehicle for human space exploration, carrying up to six astronauts to the International Space Station and up to four crew members to the Moon.

Orion comprises four elements with specific functions: the Crew Module, transporting astronauts and cargo; Service Module, housing the propulsion systems, electrical power, and fluids storage; Launch Abort System, sitting atop the vehicle and designed to pull the Crew Module away from the launch system in the event of an emergency; and Spacecraft Adapter, serving as a structural transition between Orion and its launch vehicle. The capsule will be ready for crewed flight missions by 2014.

Lockheed Martin Orion teammates include United Space Alliance, Hamilton Sundstrand, Orbital Sciences Corporation, Honeywell, and Aerojet. Among the many Lockheed Martin entities supporting Orion is Space Systems Company's Michoud Operations, providing world-class capacity for building large-scale launch hardware. NASA resumes nighttime shuttle launches as Discovery roars off the launch pad. Orion will be launched by NASA's new **Ares I** vehicle, now in the planning and development stage. Lockheed Martin is partnered with ATK and Pratt

& Whitney Rocketdyne to compete to build the upper stage. Contract award is

expected in late August 2007. The first

ics services for the test flight.

flights are planned for this year.

Ares test flight is planned for April 2009. Lockheed Martin also will provide avion-

NASA's **space shuttle** flew three times in 2006, and each time, the giant **external fuel tank** built by Michoud Operations performed nominally with little foam debris. Shortly after a spectacular flight on July 4, 2006, NASA announced plans to resume work on the International Space Station. In December, when Discovery rocketed away from Kennedy Space Center bound for the space station, it was the first nighttime launch in four years, capping off a great year for the program and the external tank. Four to five space shuttle

SPACE SHUTTLE DISCOVERY





MILITARY SPACE

HIGHLIGHT: Protecting

The payload for the first Advanced Extremely High Frequency satellite is delivered one month ahead of schedule. Development of the Advanced Extremely High Frequency (AEHF) program, which will deliver 10 times greater total capacity and channel data rates six times higher than that of Milstar II, is proceeding on schedule. The AEHF team achieved major milestones for the ground and space segments, culminating in delivery of the first flight payload and spacecraft core, a month ahead of schedule on February 6, 2007. Final assembly, integration and test are under way toward first launch in 2008. In 2006, the AEHF team received an Air Force contract to build a third satellite. Production has begun on the second and third satellites.

Execution of the critical design review (CDR) phase was the focus of the Space Systems Company–led team building the U.S. Navy's **Mobile User Objective System** (**MUOS**). MUOS will deliver net-centric, simultaneous voice, data, and video services to warfighters by leveraging third-generation mobile technology. The CDR phase, which is proceeding on schedule, will be followed by production of the first spacecraft and ground system for on-orbit handover to the Navy in 2010.

The Space Systems Company team competing for the **Transformational Communications Satellite (TSAT)** program completed milestones for spacebased laser communications and nextgeneration processor/router capabilities. TSAT will provide protected, mobile, broadband, Internet protocol-based connectivity to users around the globe. A contract award to a single contractor team is expected in late 2007.



The Defense Satellite Communications System (DSCS) III and Milstar constellations, which provide vital communications capabilities to America's military forces worldwide, achieved noteworthy milestones in 2006. DSCS III marked 175 years of cumulative on-orbit service and the DSCS team received a Chief of Staff Team Excellence Award from the U.S. Air Force. Milstar surpassed 36 years of combined operations on orbit.



MOBILE USER OBJECTIVE SYSTEM



SURVEILLANCE AND NAVIGATION SYSTEMS

HIGHLIGHT:

Protecting The first Space Based Infrared System (SBIRS) Highly Elliptical Orbit (HEO) payload is on orbit and exceeding specifications.

2006 was truly an historic year for the **Space Based Infrared System** (**SBIRS**) team, culminating on November 17, 2006 with a joint U.S. Air Force/ Lockheed Martin announcement that the first Highly Elliptical Orbit (HEO) payload was on orbit. The team also achieved major milestones on the ground segment and geosynchronous satellite (GEO) development, including successful payload and spacecraft thermal-vacuum tests and other flight hardware and software deliveries in preparation for launch in late 2008.

SBIRS will provide early warning of missile launches and simultaneously support other missions, including missile defense, technical intelligence, and battlespace characterization.

The fleet of **Global Positioning System (GPS)** Block IIR satellites marked 50 cumulative years of on-orbit operations, and



Space Systems Company launched two more IIR-M satellites for the Air Force. The IIR-M series is designed to enhance operations and navigation signal performance for military and civilian GPS users around the globe.

For GPS III, Lockheed Martin conducted a successful system requirements review and was awarded a \$50 million Air Force contract to conduct a system design review in March 2007. A contract award to a single team is expected by the end of the year. **Space Radar** is a transformational system that would provide global intelligence, surveillance, and reconnaissance for the military and intelligence community. The Lockheed Martin team, which includes Northrop Grumman, Harris, and General Dynamics Decision Systems, is working to define a constellation of spacecraft that will provide rapid-revisit coverage of the entire Earth's surface. The Air Force Research Laboratory's Space Vehicles Directorate selected Lockheed Martin to provide engineering design and development support for the **Autonomous Nanosatellite Guardian Evaluating Local Space (ANGELS)** satellite program. ANGELS provides a nanosatellite solution – small satellites weighing 22 lb. to 110 lb. – for situational awareness and anomaly characterization of a host satellite.



SENSING & EXPLORATION SYSTEMS

HIGHLIGHT: Exploring

A pair of Lockheed Martin-built solar arrays, each 38 feet wide, unfurl to their full length of 110 feet and begin generating electricity for the International Space Station.

The crew of Space Shuttle Atlantis installed the second of four pairs of massive **International Space Station Solar Arrays** and a **Solar Alpha Rotary Joint** – all built by Lockheed Martin – on the space station during STS-115 in September. The new solar arrays were brought on line during the STS-116 mission in December.

Just as on four previous servicing missions, a team led by Space Systems

Company is supporting the NASA Goddard Space Flight Center in the planning, training, and implementation of **Servicing Mission 4 to the Hubble Space Telescope**, scheduled for 2008. During five spacewalks astronauts will perform maintenance tasks and install two new instruments – the Cosmic Origins Spectrograph and the Wide Field Camera 3, significantly expanding Hubble's astronomical observing capability. Lockheed Martin successfully completed a systems readiness review and system concept review for the Program Definition and Risk Reduction phase of the National Oceanic and Atmospheric Administration's **Geostationary Operational Environmental Satellite** (**GOES-R**) program. GOES-R will be the nation's next-generation environmental satellite systems.



HIGHLIGHT: Protecting

Breakthrough research and development distinguishes Coherent Technologies as a worldwide center of excellence for laser radar.

Since becoming part of Lockheed Martin in October 2005, the **Coherent Technologies** team has made substantial contributions to the success of the company and its customers. Coherent Technologies, now united with Space Systems Company's Sensing & Exploration Systems organization, experienced significant growth – in new business and its workforce – while going through a major integration with the company. As a Lockheed Martin center of excellence for **laser radar**, Coherent Technologies is arguably the world's top developer of laser radar sensors. From research and development (R&D) to operational products, Coherent Technologies covers the full spectrum of laser radar.

Over the past year Coherent Technologies has won multiple Special Programs contracts and has a role on the Orion program with a laser-based rendezvous and docking system. Field tests continue on a new system that detects and classifies multiple biological agents such as anthrax and plague. R&D, the core of Coherent's heritage, continues to advance the capabilities of laser radar with ongoing innovations. One of those innovations, **WindTracer**[®], the first airport wind hazards lidar detection system, is already operational at airports around the world. In 2006, additional systems were installed at airports in Tokyo, Paris, Frankfurt, and Hong Kong.



HIGHLIGHT: *Exploring* The assembly, test and launch operations (ATLO) phase on the Phoenix Mars lander, NASA's next mission to Mars, is under way at Lockheed Martin facilities in Denver, Colo.



The **Defense Meteorological Satellite Program (DMSP)** F-17 Block 5D-3 spacecraft, built under contract to the U.S. Air Force by Lockheed Martin, was launched in November from Vandenberg Air Force Base, Calif., and began operations in January 2007. The Block 5D-3 series accommodates larger sensor payloads than earlier generations. DMSP is used for strategic and tactical weather prediction to aid the U.S. military in planning operations at sea, on land, and in the air.

The first science results from the NASA **Stardust** mission reveal that the comet Wild 2 contains nitrogen-rich organic molecules that could be related to the building blocks of life. Some of the material also found comes from the super-heated center of the solar nebula and predates the completion of the Sun's formation. The Lockheed Martin-built Stardust flew through the comet's coma in January 2004 and captured particles in its sample return capsule. The capsule returned to Earth in January 2006.

After five months of dipping into the Martian atmosphere to tighten into a circular orbit, the **Mars Reconnaissance Orbiter (MRO)** started its science mission in November 2006. The first images are already revealing new information about the red planet's past.

The High Resolution Imaging Science Experiment camera on NASA's Mars Reconnaissance Orbiter focuses on a scarp at the head of Chasma Boreale, a large canyon at Mars' north pole. Water ice is probably responsible for the pattern of fractures. The darkest material seen here may have been deposited as sand dunes. Exposures such as these help scientists understand recent climate variations. During the next two years, MRO will examine Mars in unprecedented detail with its six science instruments. Lockheed Martin designed, built, launched, and operates MRO for NASA's Jet Propulsion Laboratory (JPL).

Images from Mars Global Surveyor (MGS) show two new gullies that suggest water flowed on the planet's surface sometime within the past seven years. Lockheed Martin built and operated MGS for NASA and JPL. Compared to images taken of the same places over a period of years, the new MGS images are the best evidence to date that water still flows occasionally on the surface of Mars. After orbiting Mars 35,885 times over the past 9-1/2 years, MGS sent its last signal in late 2006. The spacecraft far exceeded its five-year operational expectations and leaves a living legacy of spectacular images and other information that scientists on Earth will be studying for many years.

Assembly, test, and launch operations on the **Phoenix Mars lander**, NASA's next mission to the red planet, began in April 2006. Phoenix is scheduled to launch in August 2007. After arriving at Mars' northern high latitudes in May 2008, it will dig into the ice-rich Martian soil to search for complex organic molecules.

Space Systems Company was awarded a contract by NASA's Jet Propulsion Laboratory to design and build the **Mars Science Laboratory** (**MSL**) **aeroshell** system. Scheduled for launch in the fall of 2009, the aeroshell will carry NASA's MSL rover to Mars. Lockheed Martin has built every NASA aeroshell that has entered the Martian atmosphere.

HUBBLE SPACE TELESCOPE IMAGE OF Orion Nebula



Commercial Space

HIGHLIGHT: *Connecting*

The versatile A2100 satellite achieves 150 cumulative years of on-orbit operations, underscoring the heritage, brand, and operational excellence of the spacecraft.

Achieving mission success for some of its most valued and long-term customers, Lockheed Martin Commercial Space Systems successfully launched five spacecraft in 2006, increasing the A2100 fleet to 31 satellites. The five spacecraft launched in 2006 are:

AMC-18, an advanced C-band satellite, provides cable programming and broadcast services to the 50 United States and the Caribbean. *Customer: GE Americom*.

JCSAT-9 – equipped with Ku-band and C-band channels covering Japan, Southeast Asia, and Hawaii. *Customer:* JSAT Corp.

JCSAT-10 – a high-power hybrid with Ku-band and C-band transponders covering Japan, the Asia-Pacific region, and Hawaii. *Customer: JSAT Corp.* **EchoStar X**, which features a Ku-band direct broadcast payload. *Customer: DISH Network*.

ASTRA-1KR, a high-power Ku-band satellite, provides distribution of direct-to-home broadcast services in Europe. *Customer*: **DISH Network**.

Joining the ranks of Lockheed Martin customers, Vietnam Posts and Telecommunications Group awarded Commercial Space Systems a contract to provide a turnkey telecommunications satellite system, **VINASAT-1**, in 2008. Commercial Space Systems is managing the project from design through on-orbit testing.

VINASAT-1, the first satellite system ever procured by the nation of Vietnam, is expected to improve the country's communication networks infrastructure by removing dependence on ground networks and equipping rural communities and hamlets with telephones and televisions. It also will help Vietnam enhance its role in world trade.

New customers from the Vietnam Posts and Telecommunications Group participate in a contract-signing ceremony.

STRATEGIC MISSILE PROGRAMS

HIGHLIGHT:

Protecting

With five launches in 2006, the Navy's Trident II D5 Fleet Ballistic Missile sets a new record of 117 consecutive successful test launches. The 2006 numbers are in. One hundred thirteen, one hundred fourteen, one hundred fifteen. The U.S. Navy's **Trident II D5 Fleet Ballistic Missile (FBM)** clocked a trio of test launches May 9 at the Western Range in the Pacific Ocean.

One hundred sixteen and one hundred seventeen. A two-missile test Nov. 21 at the Eastern Range in the Atlantic lofted the tally to 117 consecutive successful D5 test launches since 1989 – a record of reliability and readiness for these submarinebased missiles. As FBM prime strategic missile contractor and missile system program manager, Lockheed Martin works alongside Navy Strategic Systems Programs in California, Georgia, Washington, Utah, and Florida, where our newest facility at Cape Canaveral opened in January.

To meet prompt global strike needs, Lockheed Martin continued to advance maneuvering reentry technologies for conventional ballistic missiles under consideration. Lockheed Martin also teamed with Alliant Techsystems (ATK) on the Navy's Submarine Launched Intermediate Range Ballistic Missile Booster System Demonstration for a proposed conventional missile. The team completed design and development and test fired first- and second-stage motors in *13 months*.

The Navy answered needs elsewhere by "spinning off" the **S-Band Mobile Array Telemetry (SMART)** antenna system developed by Lockheed Martin to track D5 tests. The antenna tracked radio frequency data as an unarmed Minuteman III missile traveled some *5,100 nautical miles* in an April flight test.

On the Air Force reentry systems side of the business, October marked initial deployment of the *first* Minuteman III carrying the MK21 reentry vehicle. Part of the Northrop Grumman team for the **Safety Enhanced Reentry Vehicle**, Lockheed Martin developed the electronic and mechanical hardware that interfaces the reentry vehicle with the missile systems.

HIGHLIGHT:

Protecting

Two tests for a proposed conventional submarine-launched missile prove successful in Promontory, Utah: following a first-stage booster motor test firing July 13, 2006, Lockheed Martin and Alliant Techsytems fire a second-stage motor August 3, 2006, under a demonstration contract for the U.S. Navy.

HIGHLIGHT:

Protecting

The Lockheed Martin-led Targets and Countermeasures Program achieves a five-for-five record for customer missions in 2005 and 2006. The first 2007 mission in January expands the record to six for six.

MISSILE DEFENSE SYSTEMS

Location, location, location.

The **Terminal High Altitude Area Defense** (**THAAD**) program achieved two successful flight tests in 2006 – including an intercept – at *White Sands Missile Range, N.M.* THAAD was prepared for a third when a target anomaly resulted in a "no test," though THAAD's ground equipment acquired excellent data on the anomaly. December brought a milestone contract award for production of the first two THAAD fire units.

Three missions in 2006 for the Missile Defense Agency's (MDA) **Targets and Countermeasures Program**, all launched from the *Pacific Missile Range Facility in Hawaii*, brought the "target" success rate to five for five since the first mission in 2005. The Lockheed Martin team launched two scientific payloads for MDA's Critical Measurements/Countermeasures program in April and a target missile for the MDA test of the Aegis Ballistic Missile Defense Weapon System in June.

HIGHLIGHT: Protecting The Terminal High Altitude Area Defense weapon system keeps up the pace in 2006 with two successful flight tests at White Sands Missile Range. 2007 testing began with a successful intercept in January at the Pacific Missile Range Facility.

In Sunnyvale, Calif., Lockheed Martin completed the first kill vehicle pathfinder seeker and began hardware-in-the-loop testing of the seeker for the MDA's **Multiple Kill Vehicle** payload system. In *Redmond, Wash.*, subcontractor Aerojet completed initial testing of the kill vehicle divert thruster, demonstrating the feasibility of using a divert and attitude control system with liquid monopropellant. In the event of an enemy launch, a single interceptor equipped with the Multiple Kill Vehicle payload system will destroy the enemy lethal reentry vehicle along with any countermeasures deployed to try to spoof the missile defense system. The MDA's **Airborne Laser** (**ABL**) team rolled out the modified Boeing 747-400F aircraft in *Wichita, Kan*. Accomplishments included integration of the Lockheed Martin-designed ABL Beam Control/Fire Control System and ground tests demonstrating the ability to control the path of the illuminator lasers and the surrogate high-energy laser beam as they traveled toward a simulated target. ABL will provide the response necessary to destroy a ballistic missile during its boost phase, while it is still climbing in the Earth's atmosphere and before it can deploy its payloads.

In *Alabama*, Huntsville Operations kicked off construction of the facility's eighth building in an August groundbreaking attended by state and local officials.

The Beam Control/Fire Control System, developed by Lockheed Martin, now rides aboard the modified Boeing 747-400F Airborne Laser aircraft. Photo: U.S. Air Force ,

23

1

LAUNCH VEHICLES AND SERVICES

HIGHLIGHT: Exploring

Traveling at 10 miles per second after launch on an Atlas V, NASA's New Horizons spacecraft becomes the fastest-moving object ever to escape Earth's gravity.

Two important business transac-

24 tions that were completed in 2006 marked a new focus for Space Systems Company. The first decision was to divest the company's stake in International Launch Services (ILS), a joint venture of Lockheed Martin and Khrunichev State Research and Production Space Center of Russia. The second decision, finalized in December, was to enter into a new Lockheed Martin joint venture called United Launch Alliance (ULA) with the Boeing Company.

> Lockheed Martin and Boeing are equal stakeholders in ULA, which will provide customers with a single source for launch services. Leveraging the mission success and performance of two world-class launch teams and two launch vehicle families – Atlas V and Delta – ULA will fulfill a key space policy requirement by offering assured access to space for its U.S. government customers. Atlas V launch services continue to be provided to commercial customers by Lockheed Martin.

Work on the space shuttle's external tank continues at Lockheed Martin Michoud Operations in New Orleans, La. The shuttle fleet will be retired within the next half-decade and replaced by NASA's new Orion crew exploration vehicle, which will return astronauts to the Moon by 2020. To support the transition and prepare for its role on the new program, Michoud Operations became part of the company's Human Space Flight line of business in August (see page 3).

In January, 2006, an **Atlas V** launched NASA's New Horizons mission to Pluto and the Kuiper Belt. The threebillion-mile, eight-year journey got off to a powerful start as the spacecraft earned the distinction of being the fastest-moving object ever to escape Earth's gravity, traveling at 36,000 miles per hour (about 10 miles per second). This pioneering mission will provide the first close-up reconnaissance of Pluto and its moon Charon before venturing farther into the icy realms of the Kuiper Belt. Lockheed Martin supplied the **radioisotope thermoelectric generator** (RTG) that will provide electricity to the spacecraft as it ventures farther and farther away from available solar energy. The RTG relies on the natural radioactive decay of plutonium-dioxide fuel pellets and will still be producing more than 100 watts of electricity 80 years from now.

Three months after the New Horizons launch, another Atlas V – carrying a Lockheed Martin-built **ASTRA-1KR** satellite – performed flawlessly as it pierced the afternoon sky (see page 16). An Atlas/ Centaur launch March 8 of this year brings the launch vehicle's record of successful consecutive launches to 80 since 1993.

ATLAS V LAUNCHES NEW HORIZONS

Z-HUNE DURITADOL

Space Science and Technology Development

HIGHLIGHT: Exploring

The moment of truth for any instrument designed to function in space comes with its initial test in that environment. In December 2006, the Extreme Ultraviolet Imager passed with flying colors. The image pictured here – a mosaic showing the Sun's atmosphere at a range of temperatures – provides confirmation.

The Lockheed Martin Advanced Technology Center (ATC), renowned for aerospace research, connects technology to customer missions and creates new opportunities through innovation. In 2006, three Sun-watching instruments – designed and built at the ATC – were launched into space and began operating successfully. The Solar X-ray Imager (SXI) on the National Oceanic and Atmospheric Administration's (NOAA) Geostationary Operational Environmental Satellite (GOES 13) spacecraft saw "first light" in July. SXI will aid NOAA and U.S. Air Force personnel in forecasting "space weather" conditions and better understanding Sunrelated phenomena that affect Earth.

A suite of instruments called the Focal Plane Package was launched in September on an international cooperative solar mission called Hinode. The suite provides high-resolution optical measurements that show scientists the connections between changes in the Sun's magnetic field and features of the solar atmosphere, such as coronal heating, flares, and coronal mass ejections (CMEs) – violent explosions on the surface of the Sun.

The Extreme Ultraviolet Imager was launched in October on NASA's twin Solar Terrestrial Relations Observatory spacecraft. These spacecraft study CMEs as they propagate from the solar surface, into the solar atmosphere, and out into interplanetary space. The imager will help scientists construct the first three-dimensional views of the Sun.

Special Programs

HIGHLIGHT: Protecting

A small and persistent team turns a great idea into an important new U.S. program.

For more than 50 years, the Special Programs line of business has been delivering extraordinary solutions to some of our nation's most important and urgent challenges. Leveraging the full spectrum of capabilities across the Lockheed Martin Corporation, Space Systems Company's Special Programs provides its range of customers a legacy of secure, innovative development expertise and execution excellence.

One such program, P360, successfully marketed and contributed to the start of a major government program. The team's innovative turnkey commercialbased satellite, ground and launch system solution established the foundation for a new government architecture. The team functions across time zones from Space Systems Company in Sunnyvale, Calif., to Commercial Space in Newtown, Pa., Lockheed Martin Information Systems & Global Services in San Jose, Calif., Integral Systems in Lanham, Md., as well as Lockheed Martin divisions abroad. United Launch Alliance in Denver, Colo., rounds out the contributors with the Atlas V launch vehicle.

Following several years of concept development, market analysis, and finally proposal submittal, the contract was awarded to Lockheed Martin in October 2006. The team has had successful system and preliminary design reviews and is on schedule for launch in 30 months from contract start.

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29

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