Korean Space Launch Vehicle (NURI) 3rd Launch Press Kit

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Ministry of Science and ICT
Korea Aerospace Research Institute

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1 Overview of NURI's 3rd Launch

☐ **Launch vehicle / Launcher** : Korea Space Launch Vehicle II ("Nuri" rocket, KSLV-II) / Korea Aerospace Research Institute (KARI)

☐ **Launch site:** Naro Space Center (508, Haban-ro, Bongnae-myeon, Goheung-gun, Jeollanam-do, Republic of Korea)

○ Longitude 127.53°, latitude 34.43°

☐ Scheduled date for Nuri's third launch

○ May 24, 2023, at 18:24 (±30 minutes) (launch window: May 25 - May 31, 2023)

※ Time of launch: The exact time will be finalized on the day of launch, taking into account weather conditions and optimal time of launch that will prevent collisions with space objects orbiting Earth

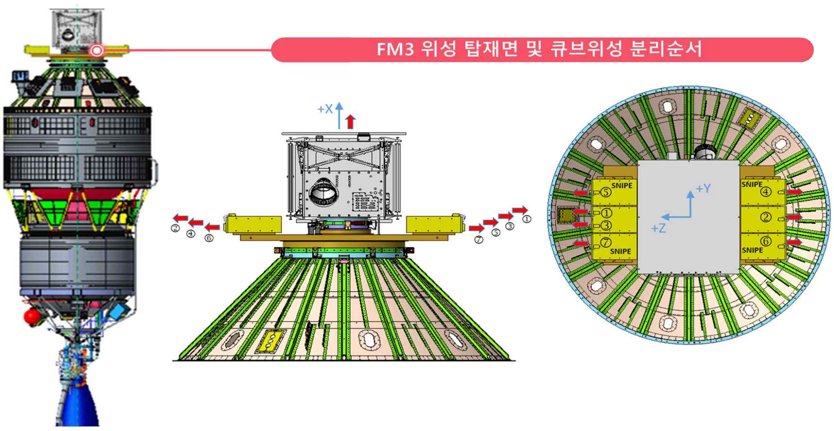
☐ **Payload for third launch: One NEXTSat-2 + seven cubesats**

○ Next Generation Small Satellite 2 or NEXTSat-2 (developed by KAIST SaTRec)

○ Cubesats (developed by Justek, Lumir, Cairo Space, and Korea Astronomy & Space Science Institute)

- For the third launch of KSLV-II ("Nuri" rocket), the third stage comprises a load/separation system for NEXTSat-2 and a load/ejection deployer for the cubesats.

※ The first test launch carried a dummy satellite, while the second test launch carried a payload consisting of a dummy satellite and performance verification satellites (four cubesats), marking the first time in history that a satellite was launched from Korea using a homegrown rocket.



Satellites to be placed on the third stage of KSLV-II ("Nuri" rocket)

2 Comparison of NURI's 2^{nd} and 3^{rd} Launch

☐ **Korea's first launch of a commercial-grade satellite**

○ Nuri's third launch is of great significance as this will be the first attempt to load and launch a commercial-grade satellite with the rocket

☐ **The first time a private company participates in manufacturing the rocket**

○ This will be the first time a private company selected as the comprehensive launch vehicle system company for this mission (Hanwha Aerospace) participates in the launch. Hanwha Aerospace was selected to receive the technology transfer for Nuri in October 2022 with the aim of enhancing the level of technological advancement in Korea's launch vehicle ecosystem.

- For Nuri's third launch, the comprehensive launch vehicle system company will be in charge of the overall management of manufacturing the launch vehicle and jointly responsible for launch operations.

※ Starting with the fourth launch, the comprehensive launch vehicle system company will gradually participate in a broader capacity depending on the level of technology transfer pertaining to launch operations, and by the sixth launch, will ultimately take part in all aspects aside from some consoles as the mission director, launch director, and launch control center.

<Comparison of Nuri's second and third launch>

	Second launch (June 21, 2022)	Third launch (May 24, 2023)
Time of launch	16:00:00	18:24 (±30 minutes) ※Launch time to be finalized depending on the satellite trajectory
Altitude	700km	550km
Gross weight	201.5t	200.4t

		Second launch (June 21, 2022)	Third launch (May 24, 2023)
Sate-llite	Payload	Performance verification satellite + dummy satellite	▶ (Main payload) NEXTSat-2 ▶ (Sub-payload) Snipe (four units), Justek (one unit), Lumir (one unit), Cairo Space (one unit)
	Weight	1,500kg in total ▶ Performance verification satellite: 180kg ▶ Dummy satellite and deployer: 1,320kg	504kg in total ▶ NEXTSat-2: 180kg ▶ Seven cubesats: 60 kg ▶ Satellite deployer and adapter: 264kg
	Separation	▶ 1st stage separation: L+875s ▶ 2nd stage separation: 70s after 1st stage separation	▶ Main payload separation: L+783s ▶ Seven cubesats ejected in 20s intervals
Total flight time		1,095 seconds (18 minutes 15 seconds)	1,138 seconds (18 minutes 58 seconds)

3 Necessity of repeated flights

☐ **Additional repeated flights*** are needed to make sure the launch vehicle is **capable of putting homegrown satellites into orbit**.

*('25)next generation mid-sized satellite-3, ('26): five microsatellites, ('27) five microsatellites

☐ As a combination of highly sophisticated and complex technologies, launch vehicles require **repeated test launches to demonstrate reliability.**

○ These iterations also help optimize and stabilize the launch process as well as improve launch reliability.

☐ **Counties leading the way** in space exploration have also conducted **repeated test launches after the maiden flight** to **boost performance and enhance reliability**.

○ Launch vehicles developed in other countries have **failed in subsequent repeated test launches** even **after the first iteration was a success**. Launch iterations have been used as a means of **addressing technical errors and enhancing the reliability of the launch vehicle**.

※ Repeated test launches of Nuri aren't simply about the success or failure of one launch. Rather than looking at these test launches through a dichotomous lens, we must recognize that the significance of these repeated test launches lies in gaining experience to improve the success rate of the mission.

☐ The comprehensive launch vehicle system company and others can gradually take lead of the production, which will help **strengthen the space industry in Korea** through technology transfers.

○ The comprehensive launch vehicle system company will **participate in the preparation and operation** of Nuri's third launch to **acquire the technology needed to take charge of subsequent private-led launches of the rocket**.

4 Overview of Payloads

1 Main payload: NEXTSat-2

○ Developer: KAIST SaTRec

○ Satellite mission

- **Localization of key technologies**: Localizing production of synthetic-aperture radar(SAR), in-space verification, and Earth observation

  ※ SAR imagery with 5M resolution and a swath width of 40km will be used for Earth observation. Unlike optical cameras, SARs are not affected by the amount of light and clouds, which means they can be used during both day and night and even during adverse weather conditions to observe Earth.

- **Space science research**: Observation of cosmic radiation in near-Earth orbit

  ※ Precision field mapping of neutrons and charged particles in near-Earth orbit, studies on the impact of increasing solar activity on cosmic radiation and the space environment, studies on the weighted value of neutrons in near-Earth orbit

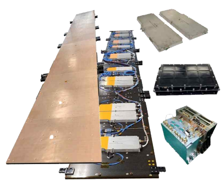
- **Verification of core technologies**: In-space verification of four types of core satellite technologies localized by businesses, academia, and research institutes

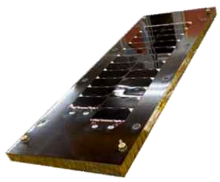
  ※ (1) Thermal control device using phase change materials, (2) GaN-based X-band amplifier, (3) combined GPS/Galileo receiver, (4) solar cell array

NEXTSat-2 Specifications

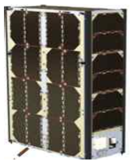
Developer	Name	System
KAIST SaTRec	**NEXTSat-2** 	- Mission life: 2 years - Altitude: 550 km (solar synchronous orbit) - Size (mm): 974 x 1340 x 820 (launch status) 5203 x 1340 x 820 (mission status) 5203 x 1340 x 820 (mission status) 5203 x 1340 x 820 (mission status) - Weight: 179.9kg - Power consumption: 2564W (max.) - Communication: S-band (remote meter-reading and command system) - Reception: X-band (reception of observation data) - Payload: SAR, cosmic ray dosimeter, thermal control device using phase change materials, X-band amplifier, combined GPS/Galileo receiver, solar cell array

○ NEXTSat-2

Payload	Details	Shape	Developer
SAR (imaging radar)	- Weight < 52.5kg - Size: (L)5203 x (W)552 x (t)40 mm3 (size of the unfolded SAR antenna) - Features: Transmits microwave signals towards the Earth and receives a portion of transmitted energy as backscatter. The returned signal is processed to construct an image of Earth. SAR can be used during both day and night, and even during adverse weather conditions.	 	KAIST SaTRec
LEO-DOS (cosmic radiation dosimeter)	- Weight < 1.7kg - Size: (L)190x(W)85x(H)144mm3 - Features: Observation of cosmic radiation absorption/equivalent dose and changes in the space environment caused by neutrons and charged particles in near-Earth orbit		Korea Astronomy and Space Science Institute

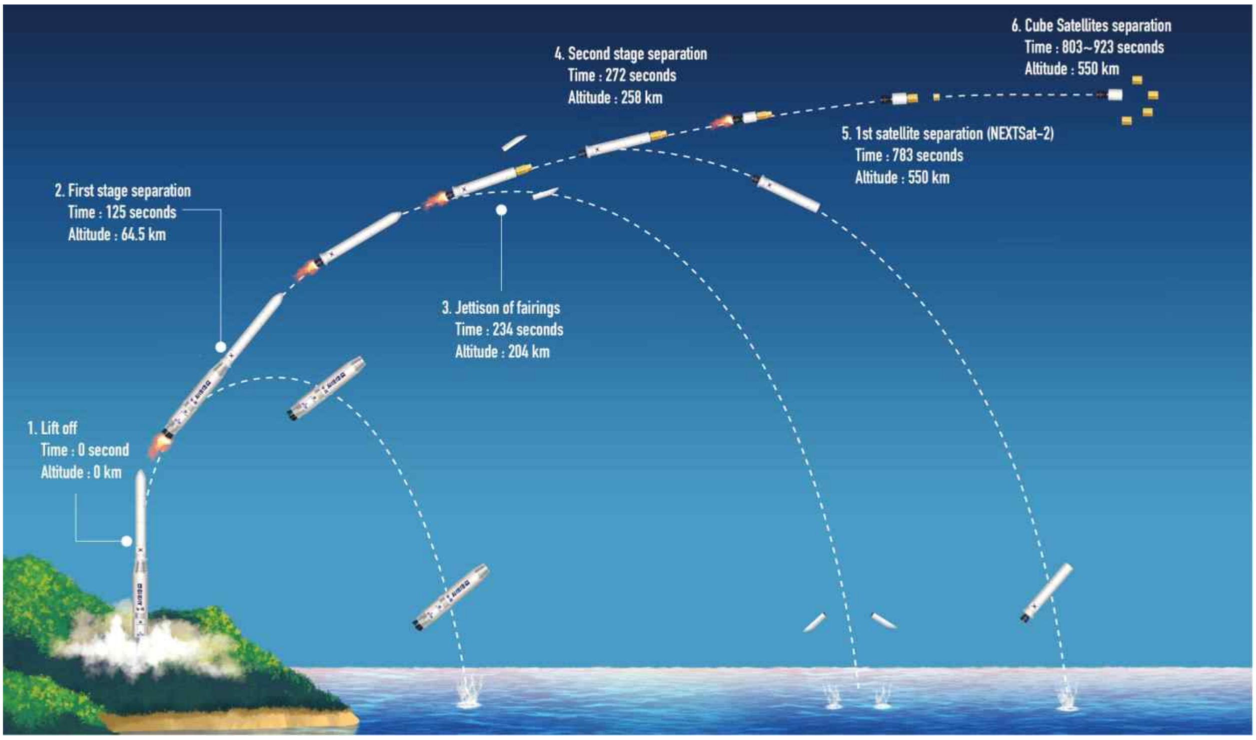
Payload	Details	Shape	Developer
PCM (thermal control device using phase change materials)	- Weight: < 2.2kg - Size: (ø)120mm x (H)60mm -Features: In-space verification of temperature control capabilities of heat generating components within the satellite using solid-liquid phase change material hexadecane, which maintains the same temperature when dormant and during phase change (target performance: 236kJ/kg)		Tech University of Korea
XSSPA (GaN-based X-band amplifier)	- Weight: < 1.5kg - Size: (L)170x(W)103x(H)50mm3 - Features: In-space verification of X-band GaN amplifier at a saturated output power of at least 120W in the form of RF pulse signals		Electronics and Telecommunications Research Institute
GPSR (combined GPS/Galileo receiver)	- Weight: < 2.3kg - Size: (L)260x(W)230x(H)44mm3 -Features: In-space verification of combined GPS/Galileo receiver capable of receiving L1/L5 signals with a location accuracy range of ±10m and velocity accuracy range of ±0.5m/s		Dusitech
SAP (solar cell array)	- Weight: < 1.0kg - Size: (L)725 x (W)250 x (t)25 mm3 - Features: In-space verification of the power generation capabilities of 20W solar panels comprising GaAs-based triple-junction tandem solar cells		KAIST SaTRec

2 Sub satellites: seven cubesats

Payload	Name	Mission & payload	System
Justek	JAC 	-To acquire in-space verification images from the optical payload (4m resolution camera) and verify the attitude control system in space so that they can be used for Earth observations - Payload: space camera (EO)	- Mission life: 6 months - Altitude: 550 km - Size / Weight: 3U* / 4kg - Power consumption: 4.8W~7.2W - Communication: UHF, S-band
Lumir	Lumir-T1 	- To demonstrate cosmic radiation measurement and error correction features in space - Payload: Microprocessor board that includes a radiation detector	- Mission life: 6 months - Altitude: 550 km - Size / Weight: 6U / 10kg - Power consumption: 12 W - Communication: VHF/UHF
Cairo Space	KSAT3U 	- To observe weather phenomenon using polarization specificity and to demonstrate space debris removal technology - Payload · 22mm polarized camera · Deorbit System	- Mission life: 1 year - Altitude: 550 km - Size / Weight: 3U / 6kg - Power consumption: 12 W - Communication: VHF/UHF
Korea Astronomy and Space Science Institute	SNIPE *Finger-four formation 	- To observe the spatio-temporal changes in the microstructure of plasma in the near-Earth environment - Payload: particle detector (SST), Langmuir probe, magnetometer	- Mission life: 1 year - Altitude: 550 km - Size / Weight: 6U / 10 kg each (total of four) - Power consumption: 12 W - Communication: UHF-band, S-band

* SNIPE will be the world's first nanosatellites to orbit in a flight formation, observing changes in space weather. These nanosatellites can orbit in both a line-ahead formation and abreast formation while maintaining the distance in between the individual units. This flight formation will help overcome the limitations of observations made using a single satellite and give us insights into the micro-level spatio-temporal changes in space plasma distribution, which will ultimately improve the accuracy of real-time forecasts of space storms and changes in space environments caused by solar wind.

5 Flight Sequence of Nuri third launch



<Flight sequence for Nuri's third flight>

Situation	Seconds after liftoff (L+)	Estimated time (based on 18:24:03 launch time)	Altitude (km)	Operation and communication procedures
Launch (liftoff)	-	18:24:03	0.1km	Liftoff
	125s	18:26:08	64.5km	First stage separation
	234s	18:27:57	204km	Jettison of fairings
	272s	18:28:35	258km	Second stage separation
	783s	18:37:06	550km	1st satellite separation (NEXTSat-2)
	803s	18:37:26	550km	2nd satellite separation (Justek cubesat)
	823s	18:37:46	550km	3rd satellite separation (Lumir cubesat)
	843s	18:38:06	550km	4th satellite separation (Cairo Space cubesat)
	863s	18:38:26	550km	5th satellite separation (SNIPE no.1)
	883s	18:38:46	550km	6th satellite separation (SNIPE no.2)
	903s	18:39:06	550km	7th satellite separation (SNIPE no.3)
	923s	18:39:26	550km	8th satellite separation (SNIPE no.4)

※ The launch sequence above is subject to change depending on the weather conditions on the day of launch.

6 Comprehensive launch vehicle system company's Scope of work

☐ **Scope of work of the comprehensive launch vehicle system company as a part of the launch vehicle advancement program**

○ According to the roles and responsibilities for each domain outlined in the **job description** agreed upon between KARI and the comprehensive launch vehicle system company, **KARI will be in charge* of launch operations**, and the **comprehensive launch vehicle system company will participate in launch operations** during the program.

* Refers to the responsibilities and authorities of carrying out launch operations.

☐ **Scope of participation of the comprehensive launch vehicle system company during Nuri's third launch**

○ Hanwha Aerospace will **observe the preparation and operation of Nuri's third launch to acquire the technology needed to take charge of subsequent private-led launches of the rocket.**

Location	No. of participants	Scope of participation
Mission Design Center (MDC)	2	Observation of launch preparations, launch mission control, launch safety, and launch support
Launch Control Center (LCC)	6	Observation of the launch vehicle preparations and testing, launch preparations, and launch operations
Launch Pad (LP)	3	Observation of the launch vehicle preparations and testing, launch preparations, and launch operations

☐ Role of the comprehensive launch vehicle system company during subsequent (fourth-sixth) iterations

○ Beginning with the **fourth iteration** of Nuri's launch, the **scope of participation will be gradually expanded, taking into consideration the level of technology transferred pertaining to launch operations**.

○ By the **sixth launch**, the **comprehensive launch vehicle system company will take part in all aspects** aside from some consoles as **the mission director, launch director, and launch control center**.

7 Various Conditions for Launch

☐ Weather conditions for launch

Classification	Launch commit criteria	Note
Temperature	- 10 °C to 35 °C	
Pressure	- 94.7 to 104 kPa	Changes in atmospheric density
Surface winds	- Average wind speed: 15 m/s, maximum instantaneous wind speed: 21 m/s	Risks to stability during launch operation
Upper winds	- Decision to be made upon measuring upper winds on the day of launch and analyzing the load and controllability (load limit: $q \cdot \alpha < 200$ kPa·deg)	Lack of flight controllability and overload
Lightning and clouds	- Conditions with no possibility of lightning discharge on the flight path	Risks of electrical damage to the payload during flight

☐ Collision with space objects

○ The launch vehicle must maintain **at least a 200km approach distance** from other manned spacecrafts **from the time of launch until the launch vehicle completes one orbit**, and a **margin of ±2 minutes will be given to the approach time**.

Target	Time	Launch commit criteria	Margin
Manned spacecraft	From launch vehicle takeoff until one complete orbit	At least 200km approach distance	Approach time ±2 minutes

☐ Impact on the space environment

○ Factoring in elements of the space environment, such as **solar activity levels (solar flares, influx of solar particles, geomagnetic disturbances, etc.)** that can affect space objects

※ Each element is categorized into six grades ranging from level 0 to level 5. Level 0 indicates ‘stable’, levels 1-3 require ‘caution’, and levels 4-5 mean ‘dangerous’.

Space elements	Subject of impact	Launch postponement criteria (recommendations)
Sunspot explosion (R)	Satellite and launch vehicle communications	- If sunspot explosions are classified as 'dangerous' (R4-R5)
Solar particle influx (S)	Electronic devices on the satellites and launch vehicle	- If solar particle influx is classified as 'dangerous' (S4-S5) - If high-energy solar particle mass is above the threshold (set forth by the Federal Aviation Administration)
Level of geomagnetic disturbance (G)	Satellite orbit errors (wobble, etc.)	- If geomagnetic disturbance level is classified as 'dangerous' (G4-G5)

Att. 1 Overview of the launch vehicle advancement program

☐ Overview

○ Goals: **Improving the reliability of launch vehicles**, and **strengthening and promoting the launch vehicle industry ecosystem** in Korea by conducting **repeated test launches** of KSLVs and **transferring technology** to the private sector.

○ Duration: 2022-2027 (six years)

○ Total cost: KRW 687.38 billion (fully funded by the state)

○ Department in charge: Ministry of Science and ICT

○ Lead organization: Korea Aerospace Research Institute, Hanwha Aerospace (comprehensive launch vehicle system company)

☐ Highlights

○ **Repeatedly launching** the Nuri rocket when the government needs to put satellites in orbit; identifying and **promoting comprehensive launch vehicle system companies** by transferring the technology used to develop the Nuri rocket

- **Strengthening launch reliability** through repeated launch iterations (four launches) of commercial-grade satellites

Category	Launch schedule	Payload
3rd launch	2023	NEXTSat-2
4th launch	2025	CAS(Compact Advanced Satellite) 500-3
5th launch	2026	Five microsatellites (2-6)
6th launch	2027	Five microsatellites (7-11)

- Encouraging private sector participation in the space industry through **efficient technology transfers and providing the demand for satellite launches** in order to create a **self-sustaining launch vehicle ecosystem**

○ **Direction**: **Strengthening the production capabilities** of participating companies and **promoting comprehensive launch vehicle system companies**

- **Mastering the production technology and improving the efficiency of manufacturing processes** by building **three KSLVs***

* KSLVs will be manufactured and launched in 2025, 2026, and 2027 through this project (the vehicle that will be launched in 2023 will be assembled individually as a part of the KSLV Development Project)

- **Accelerating technology transfer to comprehensive launch vehicle system companies**, including know-how related to the design of KSLV

Att. 2	Overview of Next-generation launch vehicle development program

□ Overview

○ Goals: Substantially increasing the nation's space transport capacity to join the ranks of advanced space powerhouses

○ Duration: 2023-2032 (ten years)

○ Total cost: KRW 2.132 trillion (fully funded by the state)

○ Details: Development of next-generation projectiles* with significantly improved performance compared to KSLV-II and securing core technologies

* Performance and scalability to meet national launch demands such as large-scale satellite launches and space exploration

□ Highlights

○ **Development goals**: developing a **two-stage*** launch vehicle with **staged combustion cycle engines**

* Five engines with 100t or more thrust in the first stage, two engines with 10t or more thrust in the second stage (vacuum thrust), staged combustion cycle engine equipped with reusable projectile-based technology (reignition and thrust control) will be applied with significant improvement in transport capacity compared to KSLV-II

○ **Launch plans**: Utilizing next-generation projectiles to meet **future demand for national satellites and space exploration launches**

- Three launches to be carried out by 2032, with lunar landers launched during the second and third launches in 2031 and 2032, respectively

	1st launch (2030)	2nd launch (2031)	3rd launch (2032)
pay load	Lunar orbital performance verification satellite	Lunar lander (PFM)*	Final model of lunar lander

*Lunar lander PFM: Proto-Flight Model for mitigating the risk of high-level technology development of the actual final model of the lunar lander

○ **Launch pad: No. 1 launch pad** at the Naro Space Center will be renovated to create a **next-generation launch pad** that can be used for low-orbit satellites and space exploration

<Comparison of KSLV-II and KSLV-III>

KSLV-II	Mission	KSLV-III
3.3t	LEO carrying capacity alt 200km (incline 80°)	Space tourism, large cargo 10.0t
2.2t	SSO carrying capacity alt 500km (incline 98°)	Multi-purpose satellite, etc. 7.0t
1.9t	SSO carrying capacity alt 700km (incline 98°)	Multi-purpose satellite, etc. 6.1t
1.0t	GTO carrying capacity 250km x 35,786km (incline 31°) (when launched eastward from the southern end of Jeju Island)	KPS satellite 3.7t
0.1t	LTO carrying capacity	Lunar lander/rover, space resource exploration 1.8t
0.0t	MTO carrying capacity	Deep space/planetary missions, asteroid recovery missions, etc. 1.0t