

2025 제 10 회 초소형위성 워크숍

Presentation [5-5]

42Abacus: An Orbital Behavior Analysis Toolkit for Satellite Constellations

유 중 현
한양대학교

42Abacus

An Orbital Behavior Analysis Toolkit for Satellite Constellations

2025. 5. 30

초소형위성워크샵, 부산 해운대, 조선포텔,

유중현 최승환 Greg Gillinger 김덕수

스페이스맵(주) / 한양대학교 기계공학부 / Voronoi Diagram 리더연구단 (NRF)
Integrity ISR

발표순서

1. Dog Fighting in Space
2. 42Abacus & ORBIX & JCO SDA TAP LAB
3. SpaceMap 소개
4. Conclusion

Dogfight



Top Gun 2 Maverick's BEST Dogfight Scene

<https://www.youtube.com/watch?v=tdW0Gv9WD>



Dog Fighting in Space

Dog Fighting in Space (우주 공간 도그파이팅)

ORBIX Analysis in 42Abaci (SpaceMap의 우주상황 분석 기능)

- 우주전 훈련
- 중국위성(5대): 스옌-24C (1, 2, 3)
(두개의 그룹) 스젠-6 05 (A, B)
- 24년 4월 ~ 25년 현재

SHIYAN 24C 01

SHIYAN 24C 02

SHIYAN 24C 03

SHIJIAN 6 05 A

SHIJIAN 6 05 B



<연합뉴스 제공, 2025. 03. 24>



Dog Fighting

3 Snapshots of Digital Twin

ORBIX Analysis (SpaceMap의 우주상황 분석 기능)

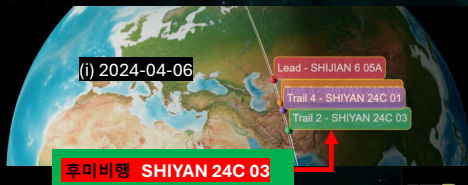
SHIYAN 24C 01

SHIYAN 24C 02

SHIYAN 24C 03

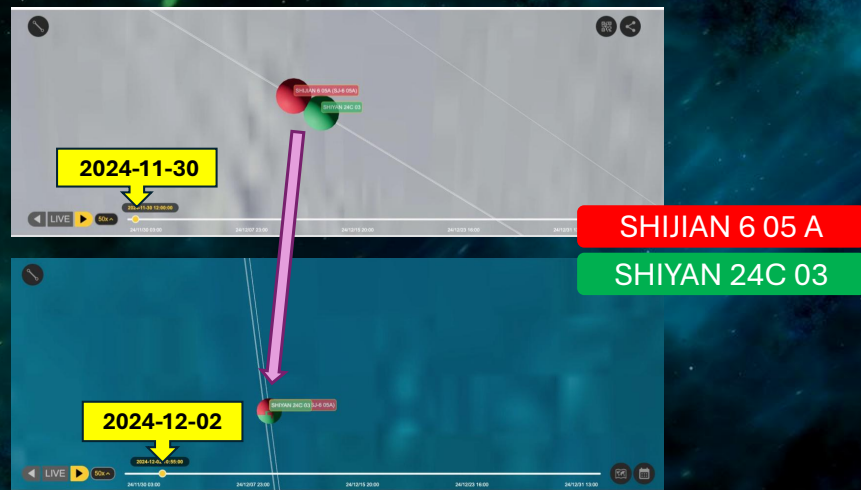
SHIJIAN 6 05 A

SHIJIAN 6 05 B



Dog Fighting in Space

- 2024년 11월 30일 12시경 RPO시작
- 12월 2일 SHIJIAN 6 05 A 와 SHIYAN 24C 03 이 최근접



<https://abaci.spacemap42.com/tubeclip/min=1732935600000&max=1733104800000&noradIds=49961,49962,58652,58651,58650&time=1733021190000>

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42Abacus

An Orbital Behavior Analysis Toolkit for Satellite Constellations

군집위성의 시공간 거동 분석도구

위협 위성 판별 탐지 및 예측 기능

<https://abacus.spacemap42.com/orbix>

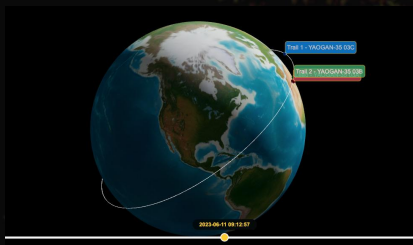
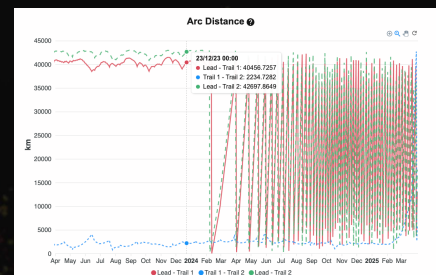
ORBIX : ORBITal analytiX

ORBIX User Interface

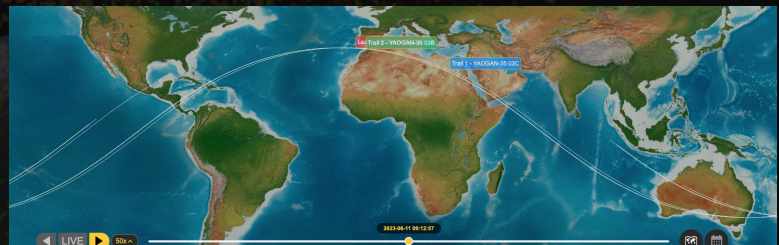
ORBIX UI \ 42Abacus

ORBIX : ORBITal analytiX

1. Arc Length Distance (원호상의 거리 계산)
2. Angular / Time Distance (각도/시간 차이 계산)
3. RAAN Distance (RAAN 차이 계산)
4. Semi-Major Axis, Inclination, Eccentricity, Perigee, Apogee, Orbital Period, Orbital Velocity, etc.



3D



Digital Twin

2D

ORBIX Functions \ 42Abacus

1. Coplanar Constellation Detection (동일 궤도 평면 군집위성 판별)
2. Similar Orbital Geometry Constellation Detection (유사 궤도 군집위성 판별)
3. Orbital Sequence Identification (궤도상 순서 결정)
4. Maneuver Detection (기동 판별)
5. Hostile Maneuver Detection in LEO (적대적 기동 판별)
6. Maneuver Detection in GEO
7. etc

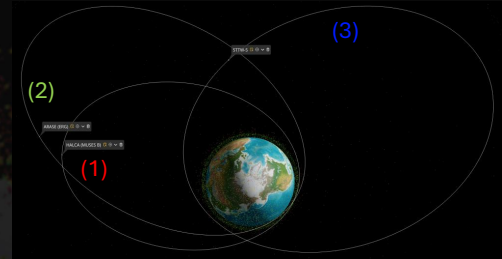
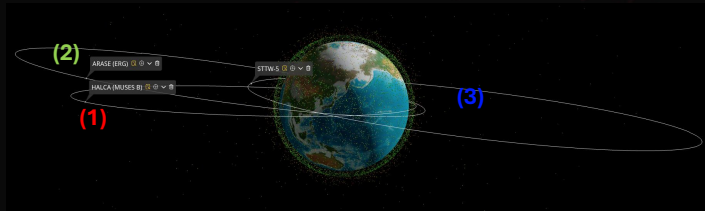
<https://abacus.spacemap42.com/orbix>

1. Coplanar Constellation Detection



Coplanarity = F (Inclination angle, RAAN, etc.)

2. Similar Orbital Geometry Constellation Detection



Coplanar

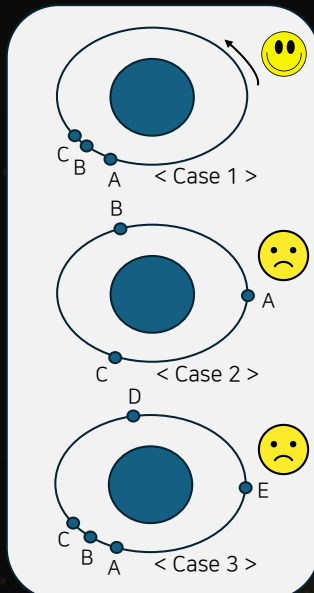
&

Similar Geometry

- (1) HALCA (MUSES B) : 24720
- (2) ARASE (ERG) : 41896
- (3) STTW-5 : 21833

13

3. Orbital Sequence Identification



Orbital Sequence Cases

- 위성 사이의 순서 판별 기능
 - 위성 군집 내에서의 상대 순서 변화를 추적 가능
 - 적국 위성이 Dog Fighting 에서 위치 교대를 하는 경우 포착 가능
 - 집단적 궤도 작전 감지 및 군집 전술 대응 전략 수립에 기여

- ORBIX 서비스
 - 순서변경 event 를 email 로 통지 (요청 시)

- Sequence Algorithm
 - For all satellite pairs
 - Check the angles & arc lengths



4. Maneuver Detection

• 기동 탐지

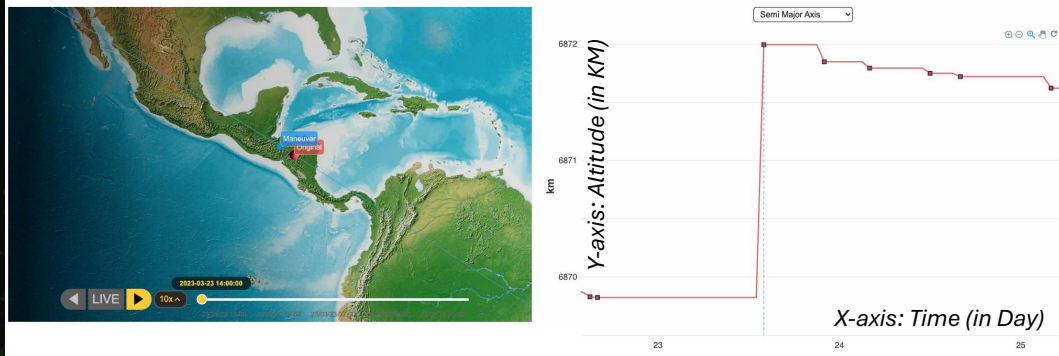
- 관측 위성의 궤도 변경을 탐지 (예: 만리경)
- 감시 및 선제 대응을 위해 필수적인 능력
- 적국 위성의 은밀한 기동을 신속 포착하는 것이 핵심

• ORBIT 서비스

- 궤도변경 event 를 email 로 통지 (요청 시)

Real-time Conjunction Assessment and Collision Avoidance of Satellites for Concurrent Avoidance Negotiation with Comparative Analysis of Passive Ranging Method and Traditional Sources

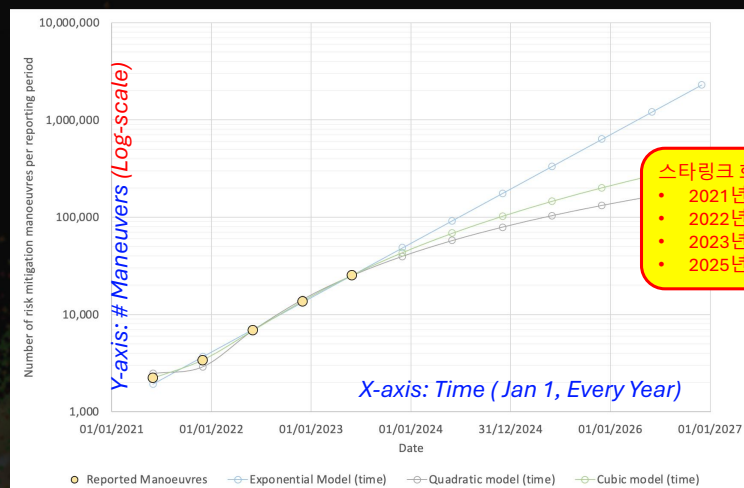
AMOS 2024 (Advanced Maui Optical and Space Surveillance Technologies Conference, Maui, HI)



Maneuver Detected

#Starlink Maneuvers

Near Exponential Maneuver Increase in Starlink (550 km Altitude)



스타링크 회피기동 횟수 (연도별)

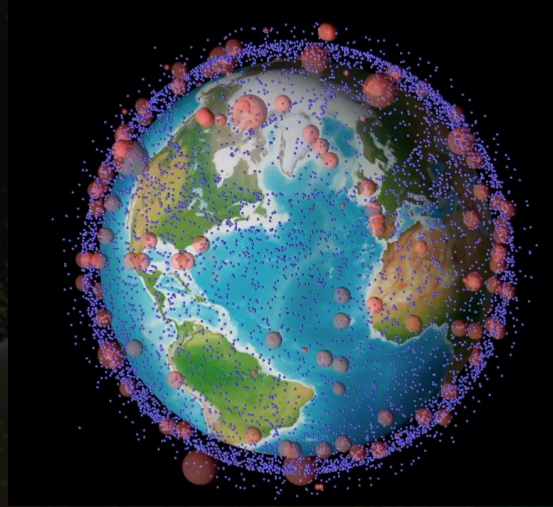
- 2021년: 2,219 회
- 2022년: 6,873 회
- 2023년: 25,299 회
- 2025년 100,000 회 (예측)

Hugh Lewis (University of Southampton, UK)

<https://www.linkedin.com/pulse/starlink-manoevre-update-july-2024-hugh-lewis-vq4be/>

XEZtron (1/2)

(Engagement Zone Predictor for X, where X = Payload, Weapon, Kinetic Energy, etc.)



US Space Force SDA TAP Lab 에서 SpaceMap 이 개발한 특수 임무 SW

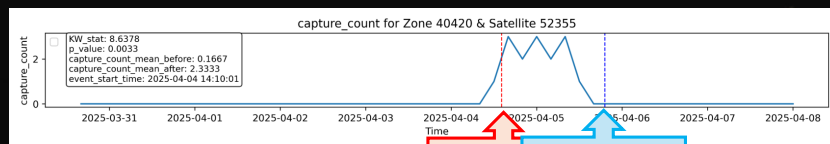
ORBIX Functions

5. Hostile Maneuver Detection in LEO

(Hostility: **BLUE** is within the engagement zone of **RED**)

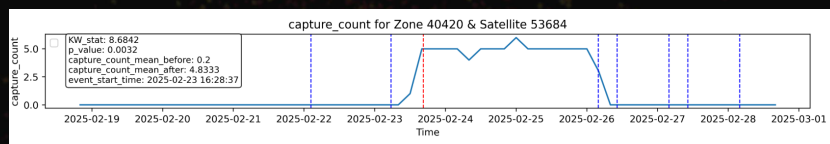
**RED Sat
40420**

Capture
Count

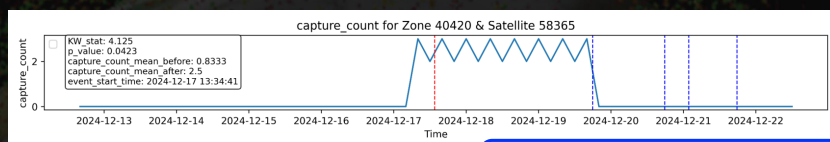


Timeline (by day)

**BLUE Sat
52355
(?)**



**BLUE Sat
53684
(?)**



**BLUE Sat
58365
(?)**

Introduced in AMOS 2024

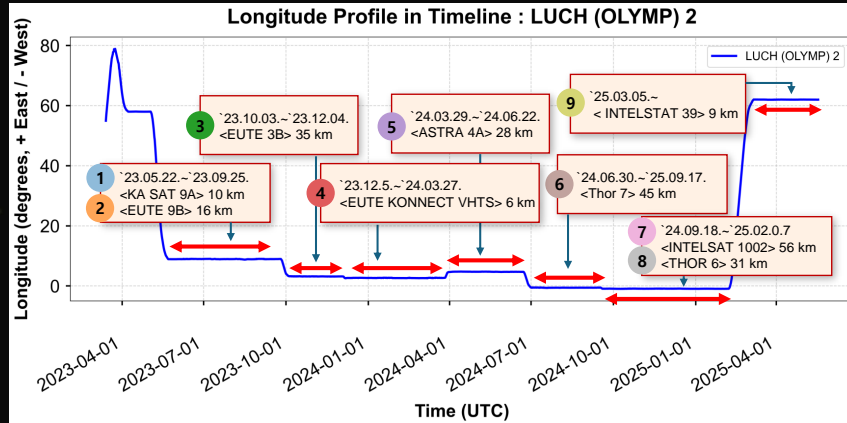
RED Satellite (40420) vs BLUE Satellite (52355, 53684, & 58365)

6. Maneuver Detection in GEO (1/3)

(Case Study of Russian SAT Anomaly : LUCH (OLYMP) 2 w.r.t. Neighbors)

정지 궤도 위성의 특이 기동 탐지 (LUCH의 궤도변경)

2023년 3월 ~ 2025년 4월 (현재)



• 이웃 위성 (유럽 통신위성)

1. KA SAT 9A (Viasat 운영)
2. EUTE 9B (Eutelsat 운영)
3. EUTE 3B (Eutelsat 운영)
4. EUTE KONNECT VHVS (Eutelsat 운영)
5. ASTRA 4A (SES 운영)
6. THOR 7 (Norway 운영)
7. INTELSAT 1002 (Intelsat 운영)
8. THOR 6 (Norway 운영)
9. INTELSAT 39 (Intelsat 운영)

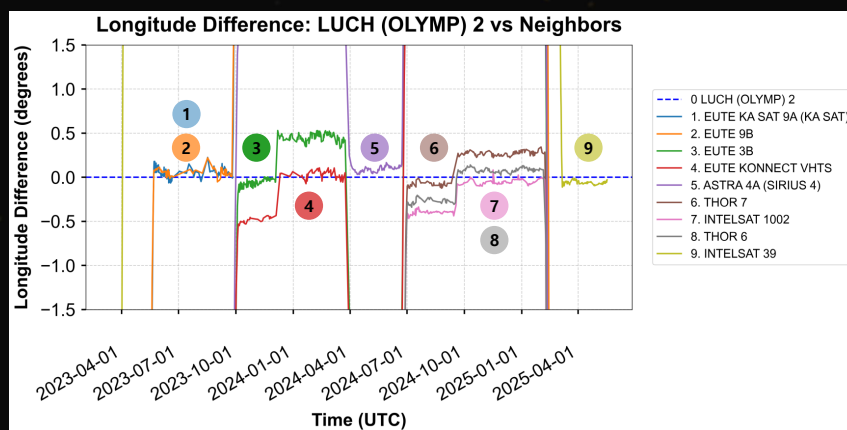
REF: Real-time Conjunction Assessment and Collision Avoidance of Satellites for Concurrent Avoidance Negotiation with Comparative Analysis of Passive Ranging Method and Traditional Sources, **AMOS 2024** (Advanced Maui Optical and Space Surveillance Technologies Conference, Maui, HI)

6. Maneuver Detection in GEO (2/3)

(Case Study of Russian SAT Anomaly : LUCH (OLYMP) 2 w.r.t. Neighbors)

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7. INTELSAT 1002 (Intelsat 운영)
8. THOR 6 (Norway 운영)
9. INTELSAT 39 (Intelsat 운영)

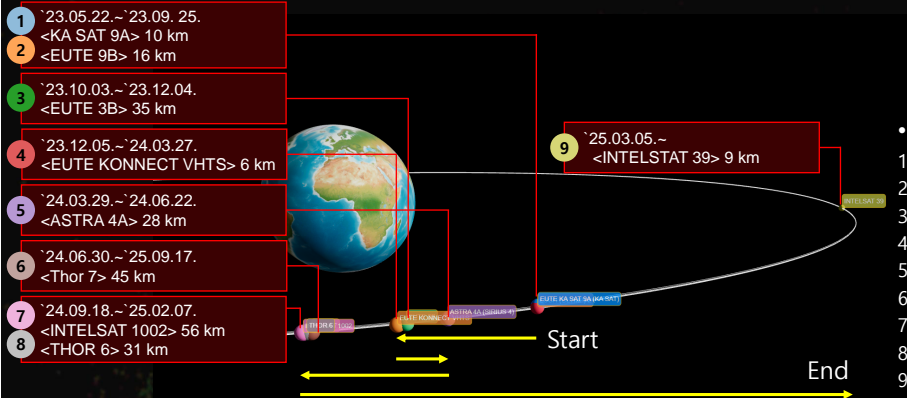
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6. Maneuver Detection in GEO (3/3)

(Case Study of Russian SAT Anomaly : LUCH (OLYMP) 2 w.r.t. Neighbors)

정지 궤도 위성의 특이 기동 탐지 (LUCH의 궤도변경)

2023년 3월 ~ 2025년 4월 (현재)



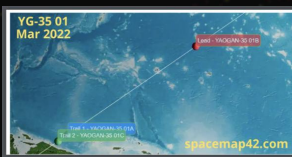
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REF: Real-time Conjunction Assessment and Collision Avoidance of Satellites for Concurrent Avoidance Negotiation with Comparative Analysis of Passive Ranging Method and Traditional Sources, **AMOS 2024** (Advanced Maui Optical and Space Surveillance Technologies Conference, Maui, HI)

Integrity ISR

1. 우주 사이버 분야 전략 솔루션 제공 기업
2. 미군, 전 세계 동맹국 우주안보 컨설팅 & 교육
3. 안보 및 산업계의 높은 신뢰
4. 보고서 email로 받을 수 있음 (무료)



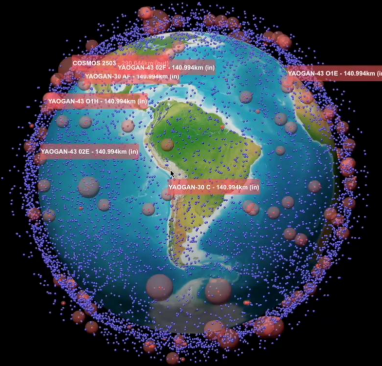
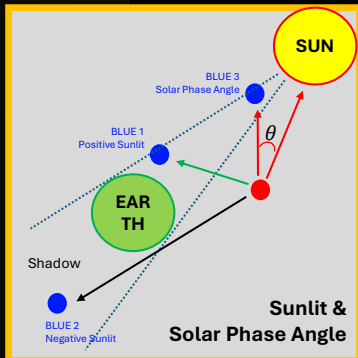
Integrity Flash 보고서의 스페이스맵 분석/화면 인용
(중국 야오강 위성 거동 분석자료)

Integrity Flash 보고서

Integrity ISR의 SpaceMap 부스 방문
2025. 3. SAT SHOW DC
Greg Gillinger, Senior Vice President
for Strategy & Development

XEZtron (2/2)

(Engagement Zone Predictor for X, where X = Payload, Weapon, Kinetic Energy, etc.)



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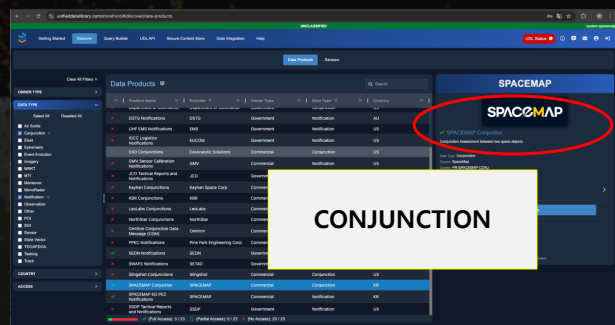
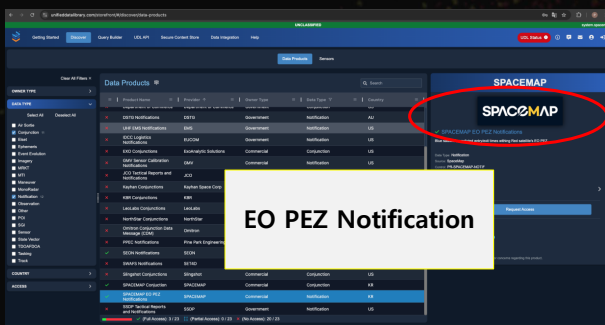
Unified Data Language UDL



UDL (Unified Data Library) Data Integration / BLUE STAQ

<https://unifieddatalibrary.com/>

미 우주군의 공식 SSA/SDA 통합 데이터관리 플랫폼



발표순서

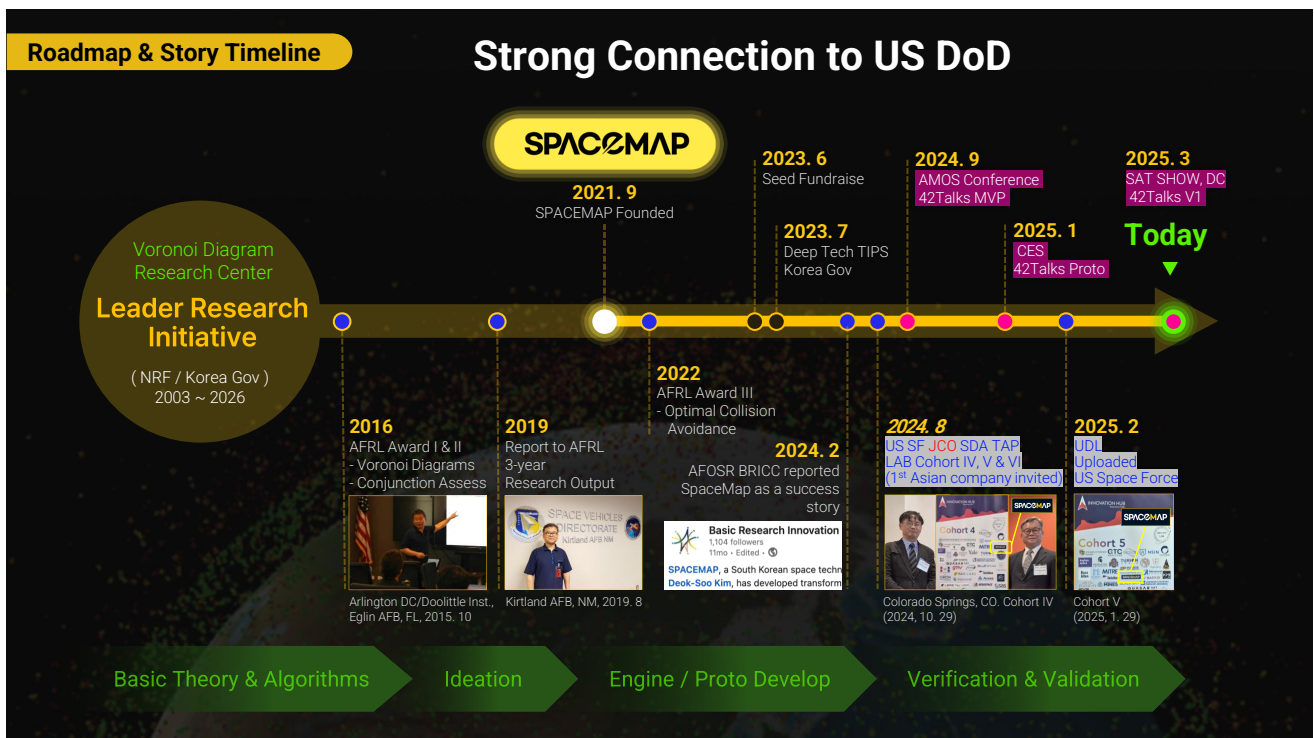
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4. Conclusion

SPACEMAP



US SF 2nd Contract

US SF JCO SDA TAP LAB Cohort 6 (May 29, 2025, 2nd Contract)



SAT SHOW DC 2025

SATELLITE SHOW, DC, 2025 9th Annual Startup Space Competition (10 Companies) (<https://www.satshow.com/press-release-startup-space/>)

2025 Competitors:

- Lee Rosen, Co-Founder & CEO, ThinkOrbital
- Sho Nakano, Founder & CEO, GITAI
- Alessandra Stabile, CEO, Magma
- Cindy Chin, CEO, Co-Founder & Chief Space Officer, Planetary Systems AI
- Douglas Deak-Soo, Founder & CEO, SpaceMap
- Jordan Vonnitsen, Founder & CEO, Odysseus Space
- Femi Ishola, Founder & CEO, Phenatron
- Noor Haj-Tamim, Founder, Avionova
- Justin Hyatt, CEO, Paramium
- Benjamin McGrossen, CEO, Ensemble Space Labs

Driving Business : Inspiring Purpose



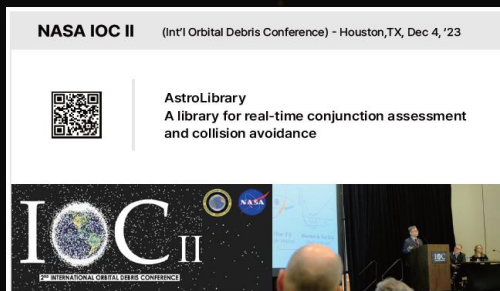
SES CEO Adel al-Saleh 방문 (CSO Nihar Shah 동반) SPACEMAP 과 협력 결정

Previous Winners (과거우승자들) : TrustPoint (2024) / MagneStar (2023) / Vyoma (2022) / AV SpaceTech and TMY Technologies (2021) / Traxyl (2020) / Eventech and Orbit Fab (2019) / LeoLabs (2018) / Astrapi Corporation (2017)

Professional Presentations

Prestigious Conferences – Oral Presentations

NASA IOC Conference



December 4, 2023, Houston

AMOS Conference



September 18, 2024, Maui

- International Conjunction Assessment workshop, Jun 2025, Toulouse, FR
- Small Satellite Conference, Aug 2025, Salt Lake City, UT

SpaceMap Vision

REUSABILITY

SpaceX reuses rockets

OrbitFab reuses satellites

SpaceMap reuses information

발표순서

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SPACEMAP

Conclusion

1. 군집위성의 거동분석은 우주 안보의 초석
2. 42Abacus / ORBIX 는 매우 유용한 계산도구
3. 미국 우주군에 지속적으로 납품하고 있음
4. 많은 수출 상담이 진행 중

SPACØMAP

The GoogleMaps for Space



인재초빙공고

SPACØMAP 과
같이 미래로 가실 분들을 모십니다.

douglas.kim@spacemap42.com



The Satellite's Guide to the Galaxy

Thank You