B07

民間 SSA：新たなリスクと事業機会

Commercial SSA: New Risks and Emerging Business Opportunities

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昨今、民間企業による通信・リモートセンシング衛星のメガコンステレーション計画の発表により、低軌道における衛星運用が注目を集めている。2020年代中には1万基以上の人工衛星を低軌道に打ち上げる計画が発表されており、既存の宇宙デブリの自己増殖と相まって、今後の低軌道の混雑化は不可避である。
また、今年6月に発表された米国の大統領令や議会の下院法案により、民間の宇宙状況把握の役割に関しては、長年にわたり宇宙の交通管理を担ってきた国防総省から商務省への移管が具体化しつつある。
これらの動向は民間の宇宙状況把握において新たなリスクとなるが、同時に新たな事業機会も生まれてくる。我々はコミュニティーとしてその両面を的確に理解し議論する必要がある。本講演では低軌道における宇宙デブリによるリスクを体系化し、各種のデータや予測を基にそこから生まれる事業機会を定量的に評価した上で、今後のビジネスの展望を提示する。

Recent announcements of planned satellite mega-constellations for telecommunications and remote sensing applications have attracted interest toward the operation of satellites in low Earth orbit (LEO). Over 10,000 satellites are planned to be launched in the 2020s and combined with the natural growth of the space debris population, congestion in LEO is inevitable.
Furthermore, with the introduction of the recent space policy directive and house bill in the United States in June of this year, the transfer of commercial space situational awareness (SSA) functions from the long-time custodian of traffic management in space, the Department of Defense, to the Department of Commerce is materializing.
These trends will introduce new risks for commercial SSA while also creating new business opportunities. We, as a community, need to accurately understand and debate both aspects of this trend. This talk will systematically examine the risks posed by space debris in LEO, quantitatively evaluate the resulting business opportunities based on various data and projections, and finally present a forward-looking view of emerging businesses in this domain.

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Disclaimer

The views, information, and opinions expressed herein are solely those of the presenter and do not represent the views, information, and opinions of their respective affiliations.

Key Topics

Who am I???

What are the **key market / environment / political factors** driving demand for commercial SSA?

What is the **status of the industry** for commercial SSA?

How can we quantify the **market size** of commercial SSA?

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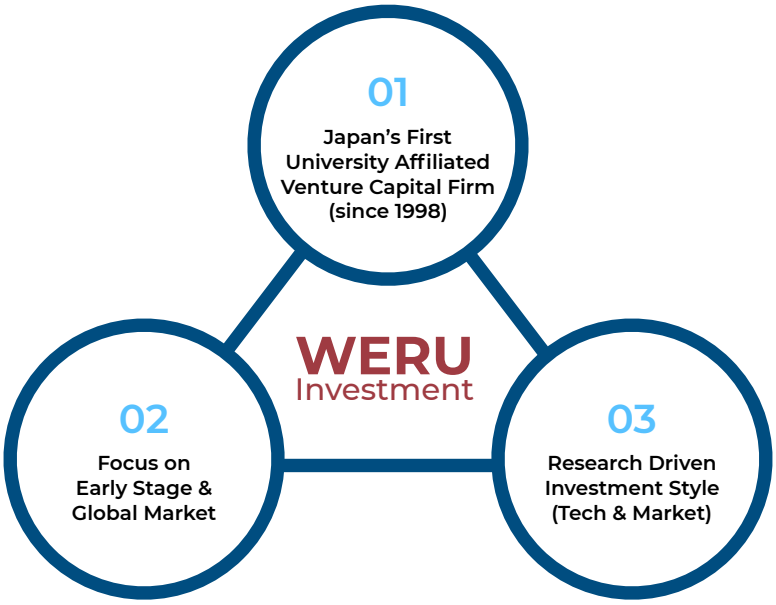
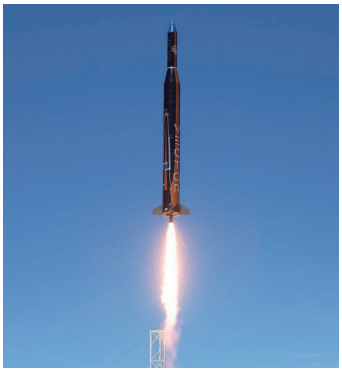
Introduction - WERU Investment



2

Introduction - Kanematsu



Kanematsu Corp. embarked on space related businesses in the early 2000s. It began handling satellites and satellite components and has enhanced its lineup of products related to space such as satellites, TT&C ground systems, and downrange stations.

We expanded into a new business area, satellite launch service, which bridges the ground and space. Demand for small satellite launches is expected to growth steadily. We will meet this demand by offering launch services using Vector's launch vehicles in and outside Japan.

兼松株式会社

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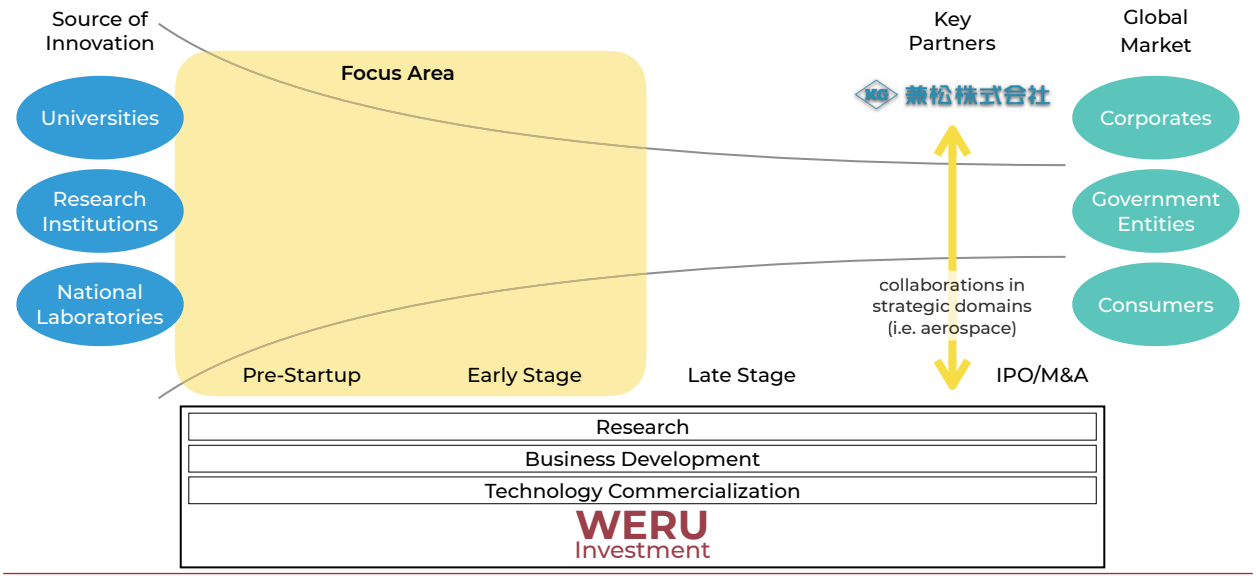
Introduction - WERU/KG Collaboration



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Key Factors in SSA - Megaconstellations & Small Satellites

The Washington Post

Elon Musk's SpaceX wins FCC approval to put 7,000 Starlink Internet satellites into orbit

By Brian Fung
November 15

Federal regulators are allowing entrepreneur Elon Musk to use an expanded range of wireless airwaves for his plan to deliver cheap, high-speed Internet access — from space.

The decision Thursday by the Federal Communications Commission paves the way for SpaceX to build its full network of about 12,000 satellites intended to blanket the earth in wireless Internet access. Proponents say next-generation satellite Internet technology could help developing countries and rural areas connect to economic opportunities currently out of reach for them because they lack competitive Internet

THE WALL STREET JOURNAL.

BUSINESS

Airbus Has High Expectations For Small-Satellite Production System

Joint venture with startup OneWeb is changing the way Airbus builds and tests space hardwa

By Andy Pasztor
July 17, 2018 3:05 p.m. ET

FARNBOROUGH, London—The head of Airbus SE's defense and space business anticipates major long-term benefits, including possibly Pentagon contracts, as a result of implementing a high-volume automated production system for small satellites.

Dirk Hoke said the production and quality-control changes—under way as part of a joint venture with Internet services provider OneWeb —will position Airbus to churn out less-expensive spacecraft using

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Key Factors in SSA - Megaconstellations & Small Satellites

		# of satellites	Orbit	FCC/NOAA Status
Telecom	SPACEX	4,425	LEO	approved
		7,518	VLEO	approved
	OneWeb	720	LEO	approved
		1,260	LEO	applied
		2,560	MEO	applied
	BOEING > SOM1101, LLC.	2,956	LEO	applied
	KEPLER Telesat LEOSAT	365	LEO	approved
EO + various	Nano/Microsatellites	2,600	LEO	various

20k+ new satellites in the 2020s

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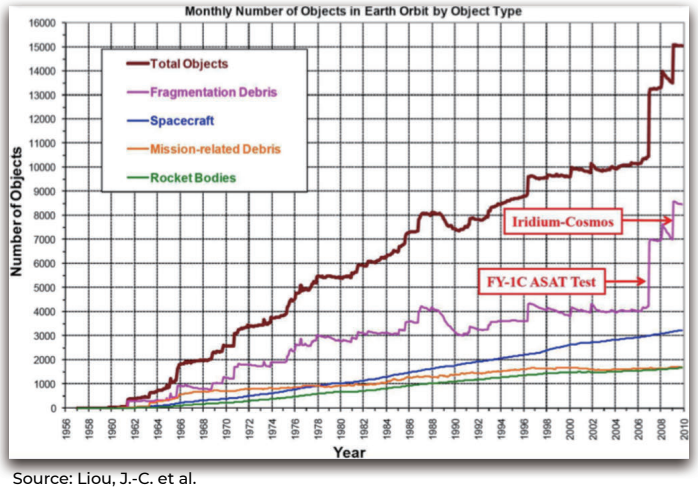
Key Factors in SSA - Debris Population

Historic Data



Source: Liou, J.-C. et al.

First 50 years of space development has steadily increased the number of on-orbit objects

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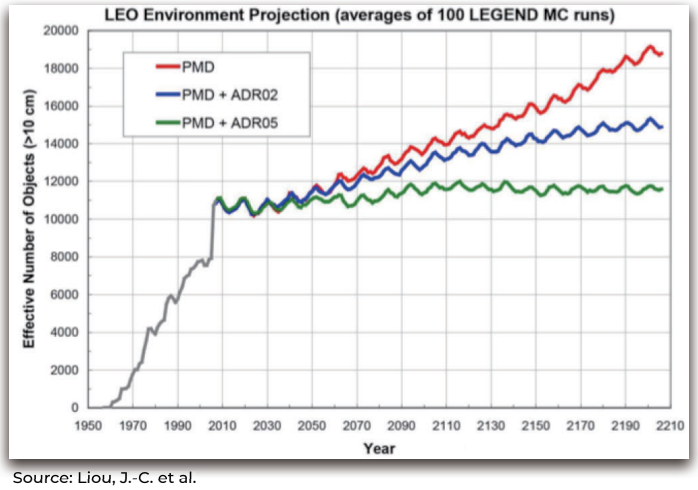
Key Factors in SSA - Debris Population

Future Projection



Source: Liou, J.-C. et al.

PMD and ADR are absolutely necessary for long-term sustainability

... but in the near-term, it's much easier to get the *expletive* out of the way

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Key Factors in SSA - Policy and Legislation in the US

SPACENEWS

NEWS OPINION VIDEO LAUNCH BUSINESS MISSIONS POLICY & POLITICS

NASA, Defense Department support giving space traffic management role to Commerce

by Jeff Foust — June 24, 2018

Commerce Secretary Wilbur Ross, NASA Administrator Jim Bridenstine and U.S. Air Force Gen. John Hyten testify at a June 22 House hearing on space traffic management. Credit: NASA/Bill Ingalls

POLITICO

Congress' growing space divide

By JACQUELINE KLIMAS (jklimas@politico.com; @jacqklimas), BRYAN BENDER (bbender@politico.com; @BryanDBender)08/03/2018 07:00 AM EDT

With help from Brianna Gurciullo, Connor O'Brien, Wesley Morgan and Adrienne Hurst

PRE-FLIGHT BRIEFING

CAPITOL HILL AT ODDS OVER SPACE REFORMS. The dramatically differing approaches of the House and Senate for overhauling commercial space regulations became clearer this week with the markup of a bill that cleared the Senate Commerce Committee and sets up a clash not only between both chambers but also likely with the Trump White House.

The House is looking to greatly enhance the role of the Commerce Department, keeping with the overall thrust of President Donald Trump's Space Policy Directive-2 and Space Policy Directive-3. The American Space Commerce Free Enterprise Act, which passed the House in April, and the American Space SAFE Management Act, approved by the House

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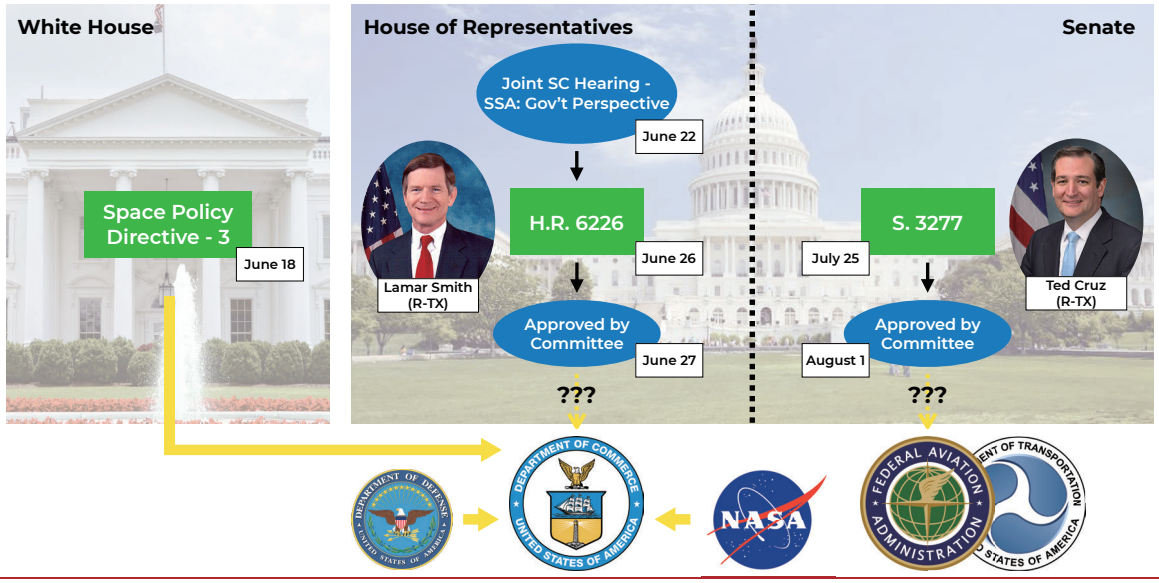
Key Factors in SSA - Policy and Legislation in the US



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Emergence of Commercial SSA

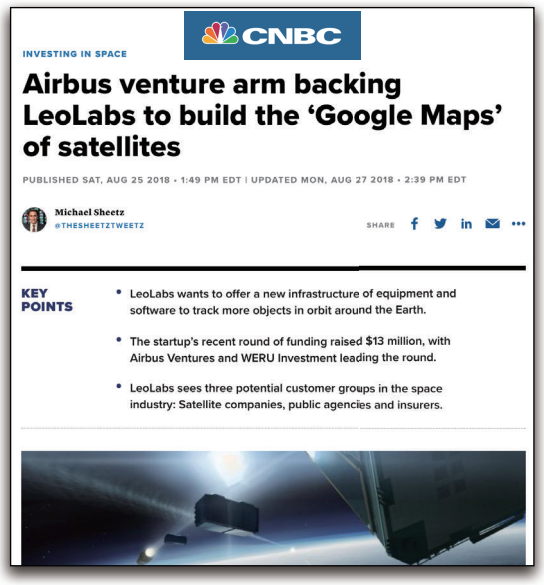
FINANCIAL TIMES

US start-up LeoLabs maps out plan to make dollars from space junk

Silicon Valley venture builds radar array in New Zealand to track orbiting debris

Jamie Smyth in Sydney SEPTEMBER 30, 2018

The small satellite revolution has transformed space into a business valued at more than $300bn, but it has also created a traffic management problem with millions of pieces of junk whizzing around the planet.



CNBC

INVESTING IN SPACE

Airbus venture arm backing LeoLabs to build the 'Google Maps' of satellites

PUBLISHED SAT, AUG 25 2018 • 1:49 PM EDT | UPDATED MON, AUG 27 2018 • 2:39 PM EDT

Michael Sheetz @THESHEETZTWEETZ

KEY POINTS

- LeoLabs wants to offer a new infrastructure of equipment and software to track more objects in orbit around the Earth.
- The startup's recent round of funding raised $13 million, with Airbus Ventures and WERU Investment leading the round.
- LeoLabs sees three potential customer groups in the space industry: Satellite companies, public agencies and insurers.

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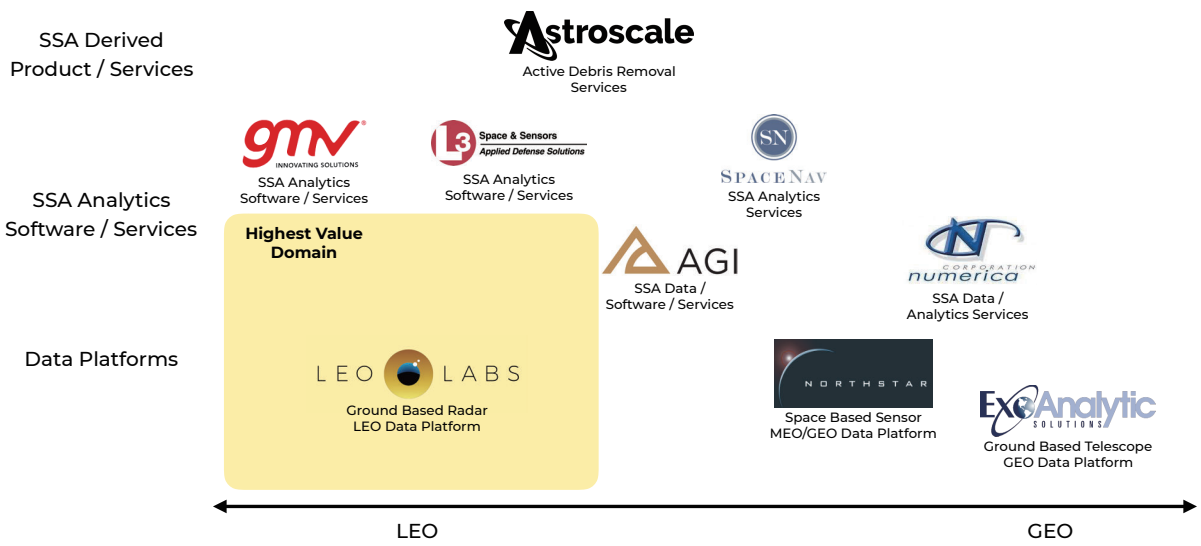
Emergence of Commercial SSA



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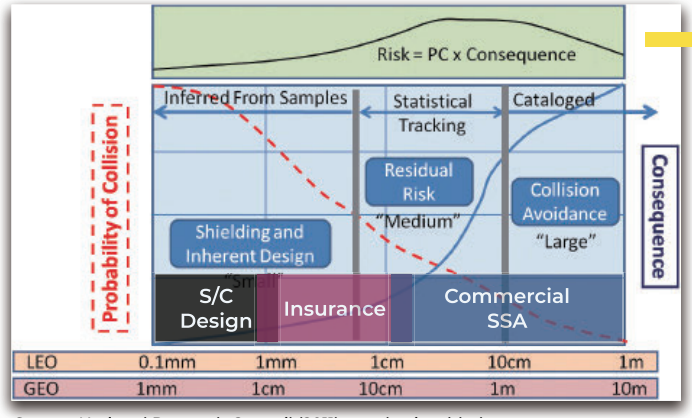
Estimating Commercial SSA Market Size



Source: National Research Council (2011); emphasis added

First Order Approximation of Commercial SSA Market Size

Market Size ≈ Risk = Annual Probability of Collision (P_c) X On-Orbit Asset Value ≈ Consequence

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Estimating the Value of On-Orbit Assets

Market Size = P_c X Asset Value

Constellation	# of Sats	Sat Size	Value per Sat	On-Orbit Value
SpaceX (LEO)	4,425	~400kg	$2~4M	$8.9~18B
SpaceX (VLEO)	7,518	~400kg	$2~4M	$15~30B
OneWeb (Base)	720	~150kg	$1~2M	$0.7~1.4B
OneWeb (Exp.)	1,260	~150kg	$1~2M	$1.3~2.5B
Boeing > SOM1101	2,956	~200kg	$1~2M	$3.0~5.9B
Telesat	117	~200kg	$1~2M	$0.1~0.2B
LeoSat	108	~1,000kg	$20~40	$2.2~4.3B
Kepler	140	~5kg	$0.3~0.6M	$0.042~0.084B
"EO + Various"	2,600	5~500kg	$0.5~1.5M	$1.3~3.9B

$30~60B in new on-orbit asset value in LEO

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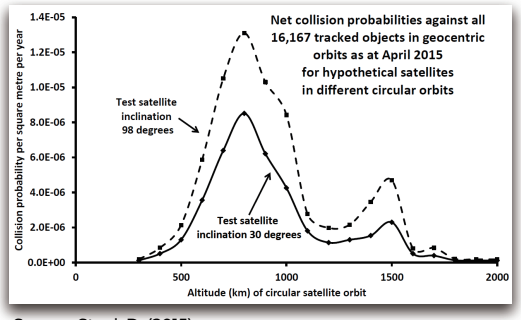
Quantifying Realistic Debris Risk

Type of Constellation	Orbit Altitude	Probability / m^2	Probability
Telecom Megaconstellation (High LEO)	1,000~1,400km	2~4 x 10^{-6}	0.02~0.04
"EO + Various" (SSO Type Orbit)	600~900km	6~13 x 10^{-6}	0.06~0.13
Telecom Megaconstellation (VLEO)	~350km	1 x 10^{-6}	0.01

single digit % per satellite probability of "close" near misses for most constellations (assuming 100m X 100m box)

At minimum, $650M~1.4B in aggregate risk exposure that can be addressed by commercial SSA (i.e. VC-backable business)

Market Size = P_c X Asset Value



Source: Steel, D. (2015)

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Some Caveats

First order analysis made key simplifying assumptions:

* Only considered a subset of LEO assets at risk
* Only considered the value of the satellite itself
* Only considered collisions with ~20k tracked objects
* Assumed a box size of 100m X 100m for all assets

Inclusion of existing on-orbit assets will increase the total value in LEO

Inclusion of launch costs and cash flow of asset will increase the total value in LEO

Better sensitivity of commercial SSA will show higher probability of collision with small debris

Better accuracy of commercial SSA will allow for smaller box sizes (= less potential collisions)

Net Effect: Market Size ↑ = Annual Probability of Collision ↑↓ X On-Orbit Asset Value ↑↑

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The power of **the lawyer** is in the uncertainty of **the law**.

–Jeremy Bentham (18th century British philosopher)

The power of **commercial SSA** is in the uncertainty of **orbits**.

–me