

R&D BRIEF

RIS(Reconfigurable Intelligent Surface) (재구성 가능한 지능형 반사 표면)

기초연구본부 선정 R&D 이슈 연구동향

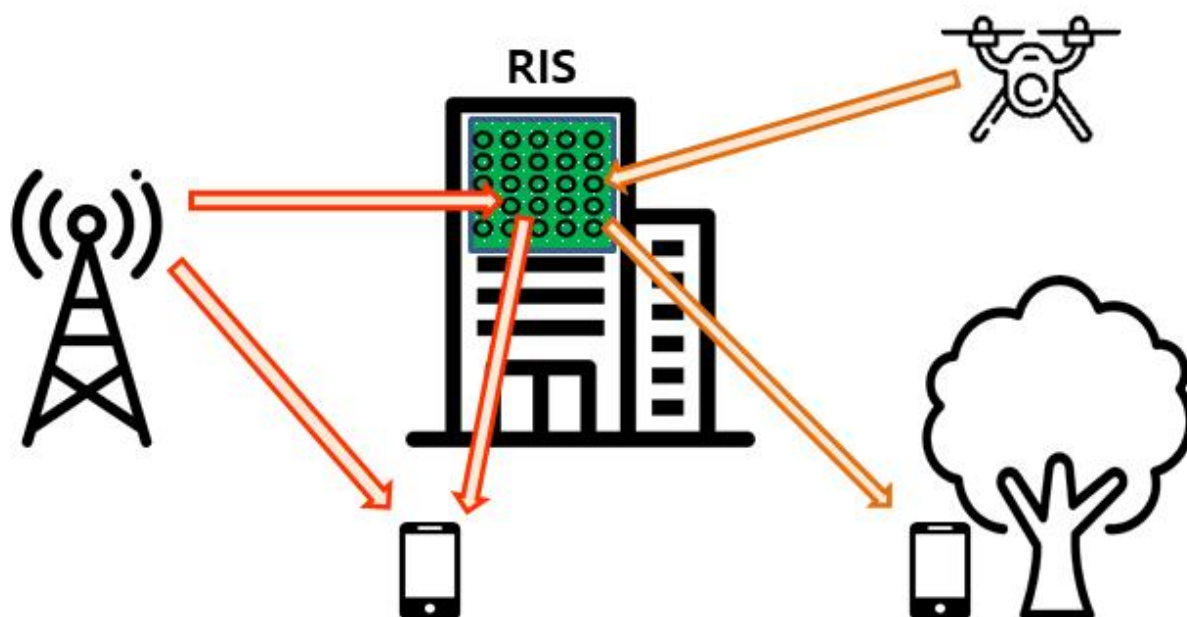
ICT · 융합연구단 성과분석위원회



1 RIS 가?

- RIS
6G

- 가 , , (SRE: Smart Radio Environment) (IRE: Intelligent Radio Environment) .
- RIS SRE Reconfigurable Metasurfaces, Intelligent Reflecting Surface(IRS) 가 .
- RIS / , , Splitting, Collimation , () , (, ETRI 36 3 2021 6)



[1] RIS

○ ‘ (, 2023.04.25.)

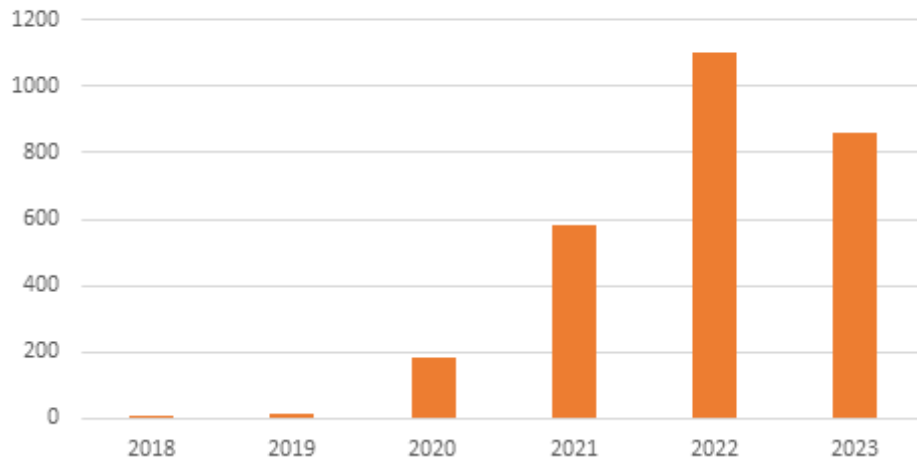
- 6G (Sub-THz, 92-300GHz), (Upper Mid-band, 7-24GHz) (THz, 100GHz-1.0THz) , 가 . , 가 .
- RIS , (3GPP) RIS .
- RIS Metasurface , , , Security .

○ 6G 가 . beamforming, wireless communications, optimisations, signal to noise ratio, MIMO systems, antennas, array processing 가 .

— scopus.com “Reconfigurable Intelligent Surface” “Intelligent Reflecting Surface” “article” 2 .

	2018	2019	2020	2021	2022	2023 (7 4)
()	3	12	185	581	1104	859

논문수



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- () European Telecommunications Standards Institute(ETSI) Industry Specification Group(ISG) RIS

- 2021.10 RIS ISG
- Samsung, Apple, Huawei, Qualcomm, ZTE, NEC 40
- 2023.04 RIS , (ETSI GR RIS 001 V1.1.1)
- 2023.06 RIS , , (ETSI GR RIS 003 V1.1.1)

- () Institute of Electrical and Electronics Engineers(IEEE) RIS

- IEEE Communications Society(ComSoc) Emerging Technology Initiative on Reconfigurable Intelligent Surface(ETI-RIS)
- IEEE ComSoc Wireless Communication Technical Committee(WTC) Special Interest Group(SIG) – Reconfigurable Intelligent Surfaces for Smart Radio Environments(RISE)
- IEEE ComSoc Signal Processing and Computing for Communications Technical Committee(SPCC-TC) SIG – REconFigurabLE Intelligent Surfaces for Signal Processing and CommunicatIONS(REFLECTIONS)
- RIS

○ () Huawei, ZTE

RIS

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■ Huawei	2022.12	“Terahertz Sensing and Communication Towards Future Intelligence Connected Networks”	RIS가	가
■ ZTE	2022, 2023	Mobile World Congress(MWC)	RIS	.
– 2022		RIS	.	
– 2023		가	RIS	.
■ 2023.03		RIS Tech Alliance(RISTA)		RIS

○ () , LG U+, SKT, KT

RIS

가

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■	가	2020	6G	RIS가
				(Samsung, “6G the next hyper-Connected experience for All”).
■ SKT	2020		가	가
			RIS	.
■ KT				
				RIS
■ LG U+	POSTECH			.
가	RIS			.

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※ : ‘RIS(Reconfigurable Intelligent Surface)’, ‘IRS(Intelligent Reflecting Surface)’, ‘meta surface’, ‘’, ‘’, ‘meta surface antenna’

○ : (RIS) 2020

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가 2020

가 가 .

	2017	2018	2019	2020	2021	2022
()	5	7	11	18	27	39
()	349	619	792	1216	3111	5294

※ .

※ (e-R&D) ‘RIS(Reconfigurable Intelligent Surface)’, ‘IRS(Intelligent Reflecting Surface)’, ‘meta surface’, ‘ , ‘ , ‘meta surface antenna’ 가

/			()	2014
/				2015
/				2015
/		5G 가		2015
/				2016
/		5G 가	()	2018
/		energy hot spot ID		2018
/				2018
/				2019
()		가		2020
()		6G THz		2020
/				2020
/				2020
	()	RBAS: 가		2020
/				2020
/	()	energy hot spot ID		2021

		RIS	—	2021
()	()		IoT	2021
/			B5G/6G	2021
/				2021
()		K-Starlink:	가	2021
()		—		2021
()				2021
()		/		2021
()		6G	(AIRS: Artificial Intelligent Reflecting Surface)	2021
/		—		2021
()				2021
()		6		2021
/		5G+/6G	/	2021
()	()		6G	2021
/				2022
	()	RIS CF-mMIMO IoT-Enabled Beyond 5G		2022
		AI	End-to-End/D2D QoS	
()		5G/6G		2022
()			6G	2022

()		— : —		2022
()				2022
/		6 — —		2022
/				2022
()	()	6G		2022
/		B5G/6G		2022
()	(ERICA)	가		2022
()		가		2022
()				2022
		/ AIoT		2022
()		6G		2022
	()	가 6G THz		2022
/		가 가		2022
()		가 IR-UWB		2022
()		Pre-6G/6G / / / / (3CLS)		2023
()		6G mmWave/THz 가		2023

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■ 2015 9 -2024 8

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■ RF : , /

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■ 2016 6 -2018 5

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■ 2020 3 -2023 2

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6G	THz
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■ 2020 9 -2023 2

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■ THz IRS MIMO

- THz

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- robust THz

- IRS MIMO

■ THz

- THz

- IRS THz

- - THz

■ THz

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- -IRS-

- THz

ID	energy hot spot
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■ 2021 3 -2025 2

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■ 3 가

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■ 4 HW 가

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- 4

- 가 4 HW

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6G	(AIRS: Artificial Intelligent Reflecting Surface)
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■ 2021 3 -2026 2

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■ RIS

- (5G NR)
- (convergence proof)
- Online Meta-learning: ‘ , ’

- RIS (Reference wave) / (Illuminating wave)
- RIS (Reconstructed wave)
- (zero-pilot)
- () RIS (AIRS)
- RIS (Active beamforming) RIS (Passive beamforming)
- OFDMA –RIS –RIS
- RIS LLS SLS 가 RIS LLS (BLER MCS)
-)
- RIS) (e.g.,
- LLS SLS
- AIRS LLS/SLS
- AIRS RIS LLS SLS
- AIRS LLS/SLS
- SLS SLS



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- 2021 3 -2026 2
- < >
- 가
- 가 – (Mechatronic)
- 가 FPGA (Actuator)
- 가
- (Absorbing Metasurface) , 가
- 2 가 (Absorbing Metasurface)

- 가
 - (Reflecting Metasurface)
 - Phase Code Space Code 가 Code Book
- 가
 - (Diffusion Metasurface)
 - Phase Code Space Code 가 Code Book
- / / 가
 - 가 (Programmable Metasurface)

6G

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- ()
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- 2021 6 -2025 5
- < >
- IRS IRS pilot
 - IRS
- IRS
 - IRS 가 가 AI IRS
 - NOMA RSMA
- , IRS
 - single-agent multi-agent RL
- Cell-free network IRS
 - cell-free network
 - , 가

5G/6G

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- 2022 3 -2025 2
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- - A2C(advantage actor-critic), DDPG(deep deterministic policy gradient) ,
 - 가
 - Ray tracing
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 - Ray tracing

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■ 2022 3 -2025 2

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■ IRS

– IRS

– Polarized IRS

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IRS

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■ 2022 6 -2025 2

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RIS

– RIS

■ RIS 가

– RIS

■ RIS 가

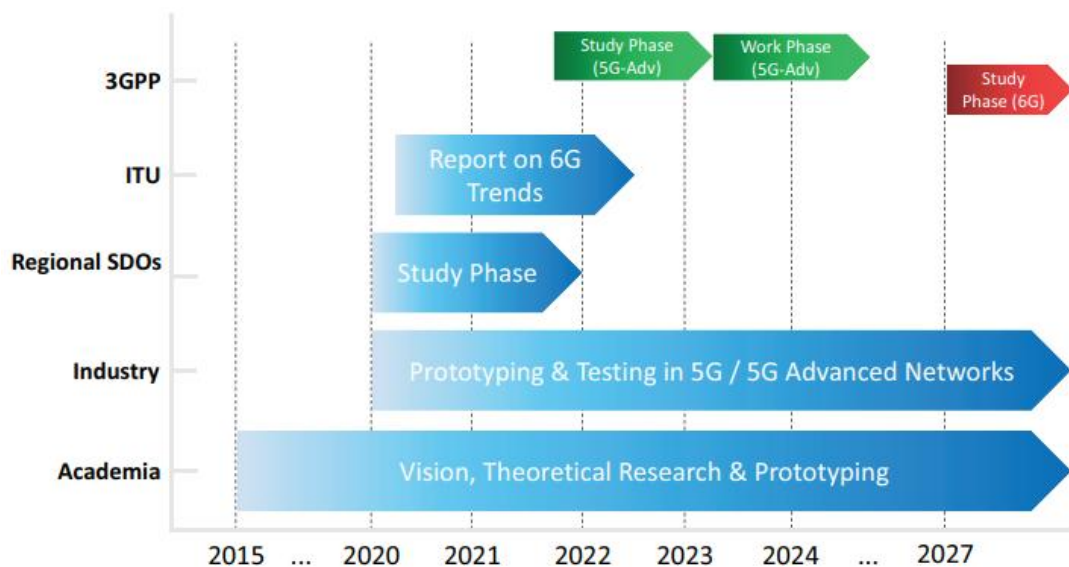
– . RIS

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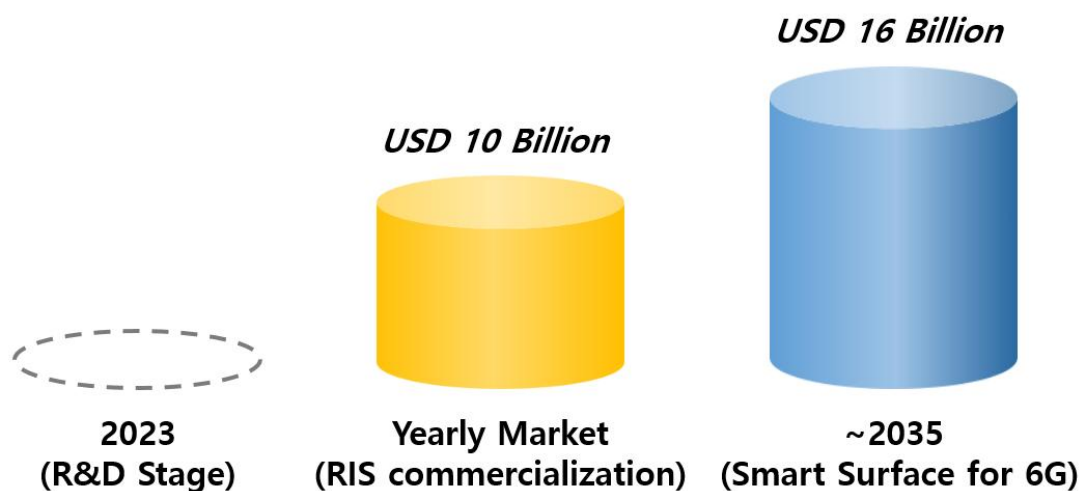
- 2023 RIS R&D/pre-standard , (- 2
- B5G , 2022). RIS 5
- , RIS 6G

- , RIS (ETRI “ , 2021)
- RIS , 3GPP 5G-Adv/6G < 2> (“A Path to Smart Radio Environments: An Industrial Viewpoint on Reconfigurable Intelligent Surfaces”, 2021)
- RIS 100 < 3> (Zhar Research, “6G Communications: Reconfigurable Intelligent Surface Materials and Hardware Markets: GHz, THz, Optical 2023–2043”, 2022)
- 6G Smart surface 가 2035 160 < 3> (Mind Commerce, “Smart Surface Market by Solution, Sector and Industry Verticals 2022 – 2027”, 2022)



[3] RIS

RIS(Reconfigurable Intelligent Surface) Market



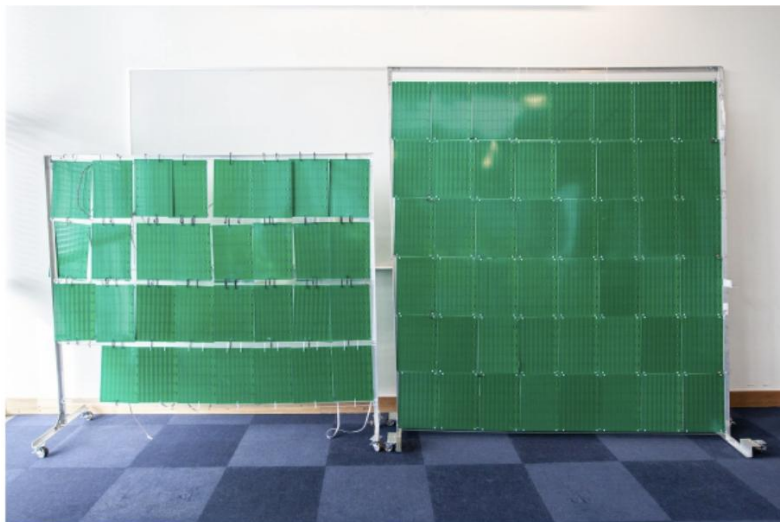
[4] RIS

○ () EU(Europe Union) RIS

- 2017 , EU Hyper surface
- 2021 5 , EU VISORSURF RIS /
- 2022 3 , EU PathFinder (SWC) SURFER

○ () MIT, UC SANDIEGO RIS

- 2020 2 , RFocus 3720 가 (MIT) RFocus< 4> . RFocus
- 2020 , San Diego ScatterMIMO 30m 45m

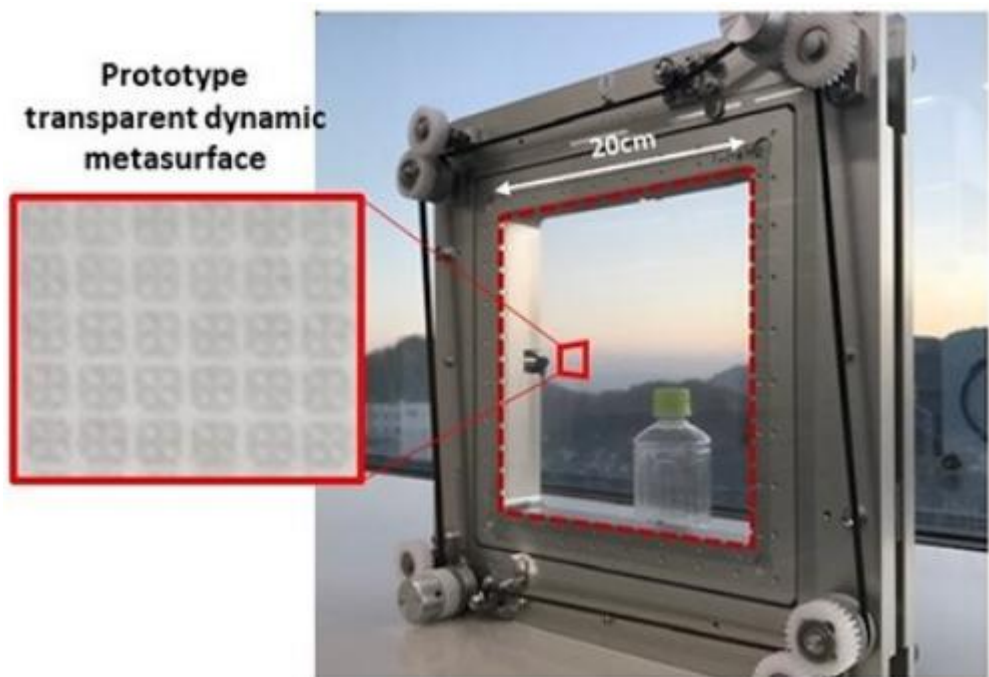


[5] MIT RFocus Prototype

○ (,)

- 2018 11 , 28GHz 5G NTT DOCOMO metawave
- 2021 1 , NTT DOCOMO AGC 28GHz 5G

	.< 5>	28GHz
■	2023 4 5G 28GHz RIS	RIS
■	2021 8 Huawei, Innovation Laboratory RIS	Future Network System Optimization
	RIS	가
■	2022 , China Unicom Rohde&Schwarz, RIS	



[6] NTT DOCOMO RIS

○ () LG U+, SKT, KT

■ SKT	6G	RIS
< 6> (	, 2022.08.30.).	
■ KT	RIS	
KT	RIS	5G 가
	(	, 2022.11.15.).
■ LG U+ POSTECH,	RIS	110
	(	, 2023.04.24.).



[7] SKT RIS

□

가?

	■ RIS - RIS /RIS RIS - RIS 가 , RIS - 가 RIS . ■ RIS - RIS RIS
	■ RIS - , , / RIS .
	■ NTN RIS - , (NTN) MIMO - LoS(Line of sight) shadowing/blocking RIS . - , RIS / - SWaP UAM, RIS .
	■ - , , RF , RIS /



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	■ , / , — 가 RIS - 가 6G — , 6G RIS , , .
	■ — 6G RIS RIS .
	■ — , , 가 . —

8

가?

	■ RIS — 6G 3D RIS — RIS — AI RIS
	■ RIS , , 가 RIS — RIS 가 .
	■ RIS — , , / , RIS () — RF / , RIS -가 (,) / — RIS 가 RF ■ / — RIS 가 / / — RIS 가 / ■ RIS RF — RIS /가 Ray tracing — RIS / Feedback ■ RIS — RIS / /

저자소개

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NRF R&D BRIEF 2024-5호

RIS(Reconfigurable Intelligent Surface)

(재구성 가능한 지능형 반사 표면)

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|발행처| 한국연구재단

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