

UNCLASSIFIED

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319: <i>Research, Development, Test & Evaluation, Navy / BA 7: Operational Systems Development</i>	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>
---	---

COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
Total Program Element	0.000	29.932	50.978	0.000	-	0.000	-	-	-	-	-	-
0728: <i>Navy Multiband Terminal (NMT)</i>	0.000	29.932	20.292	0.000	-	0.000	-	-	-	-	-	-
0729: <i>Mobile Advanced Extremely High Frequency (AEHF) Terminal (MAT)</i>	0.000	0.000	21.686	0.000	-	0.000	-	-	-	-	-	-
9999: <i>Congressional Adds</i>	0.000	0.000	9.000	0.000	-	0.000	-	-	-	-	-	-

Program MDAP/MAIS Code:
Project MDAP/MAIS Code(s): 290

Note

Funding for the following projects has been realigned out of PE 0303109N into PE0604280N as part of Program Element Consolidation starting in FY22: Project 0728 Navy Multiband Terminal (NMT) and 0729 Mobile Advanced Extremely High Frequency (AEHF) Terminal (MAT).

A. Mission Description and Budget Item Justification

(0728) The Navy Multiband Terminal (NMT) Program is the required Navy component to the Advanced Extremely High Frequency (AEHF) program for enhancing protected and survivable satellite communications to Naval forces. The NMT system provides an increase in single service capability from 1.5 Megabits per second (Mbps) to 8 Mbps, increases the number of coverage areas and retains Anti-Jam/Low Probability of Intercept (AJ/LPI) protection characteristics. It is compatible with legacy Navy Low Data Rate/Medium Data Rate (LDR/MDR) terminals and will sustain the Military Satellite Communications (MILSATCOM) architecture by providing connectivity across the spectrum of mission areas, to include land, air and naval warfare, special operations, strategic nuclear operations, strategic defense, theater missile defense, and space operations and intelligence in support of Resilient Command and Control (RC2) initiatives. The NMT system replenishes and improves on Navy terminal capabilities of the Military Strategic, Tactical & Relay System (MILSTAR), Defense Satellite Communications System (DSCS), Wideband Global Satellite (WGS) and Global Broadcast Service (GBS). The new system equips warfighters with the assured, jam resistant, secure communications as described in the joint AEHF satellite communications system and WGS Operational Requirements Documents (ORD).

(0728) The Wideband Anti-Jam Modem System (WAMS) is a Navy technology upgrade that enhances communication capability of shipboard and submarine NMTs by providing wideband Anti-Jam (AJ) Satellite Communication throughput over Wideband Global SATCOM (WGS). WAMS is a major contributor in supporting the National Defense Strategy by investing in resilience to provide assured communications capabilities. WAMS enables space segment Anti Jam (AJ) diversity (EHF/AEHF and WGS), thus enabling NMT ships and submarines equipped with the modem to operate in wideband links closer to threat jammers. The United States Air Force (USAF) Protected Tactical Enterprise Service (PTES) program will provide the ground hub component of the WAMS communication system. This PTES joint hub will serve as a DoD enterprise service ground solution for the use of the Protected Tactical Waveform (PTW) of SATCOM communications and introduces a Network Operations Without Shore (NOWS) capability. The NOWS capability will use the Direct Sequence Spread Spectrum (DSSS) waveform that provides uninterrupted communication

UNCLASSIFIED

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Navy	Date: May 2021
---	-----------------------

Appropriation/Budget Activity 1319: <i>Research, Development, Test & Evaluation, Navy I BA 7: Operational Systems Development</i>	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>
---	---

in case of loss of shore hub connectivity. PTW is a Frequency Hopped Spread Spectrum (FHSS) waveform that provides high data rates in a benign environment and anti-jam protection to meet contested data rate requirements. High data rate anti-jam capability is enabled via the Protected Tactical Waveform (PTW) and low data rate anti-jam capability is provided via the Direct Sequence Spread Spectrum (DSSS) waveform. These two waveforms are designed to operate over the Wideband Global SATCOM system as well as other transponded satellites, and are also forward compatible with the on-board processing capabilities of the future Protected Tactical Satellites (PTS). WAMS enables the use of WGS X and Ka-band resources to assure access to mission critical communications to provide Resilient Command and Control (RC2) capabilities in contested/degraded environments, formerly known as Anti-Access/Area Denial (A2AD). The use of WAMS PTW on WGS will augment AEHF Extended Data Rate (XDR) services to provide the information throughput capacity necessary to support critical Command and Control capability.

(0728) Navy Global Broadcast System (GBS) is a member of the larger Joint C4I program, providing high speed (up to 45 Mbps per transponder)/large volume information/data delivery to forces afloat, ashore, and Naval Special Warfare Command. Leveraging the NMT antenna, GBS provides a one-way broadcast to Naval maritime forces across the spectrum of mission areas, to include land, air and naval warfare, special operations, strategic nuclear operations, strategic defense, theater missile defense, and space operations and intelligence in support of RC2. GBS Transmission Security (TRANSEC) is an operational requirement from the Joint GBS ORD and provides robust datalink protection of both uplink and downlink for the GBS broadcast. GBS is evaluating Protected Tactical Waveform (PTW) solutions to meet the TRANSEC mandate. The Air Force & Army Anti-Jam Modem (A3M) and the WAMS are PTW solutions that are under consideration. Navy GBS will require extensive development activities for the new PTW modem solution and must conduct a FOT&E with Joint Services. Overall program efforts include technology insertion studies required to support satellite communications.

(0729) Satellite Communications: The details of Program Element 0303109N, Project 0729 are classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books.

(9999) Congressional Add provides for the development, test and evaluation of enhanced capabilities for the Navy Multiband Terminal (NMT) by furthering Science & Technology (S&T) research and transition activities associated with resilient communications capabilities.

B. Program Change Summary (\$ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	34.344	41.978	28.041	-	28.041
Current President's Budget	29.932	50.978	0.000	-	0.000
Total Adjustments	-4.412	9.000	-28.041	-	-28.041
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	9.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-2.233	0.000			
• SBIR/STTR Transfer	-2.180	0.000			
• Program Adjustments	0.000	0.000	-28.049	-	-28.049
• Rate/Misc Adjustments	0.001	0.000	0.008	-	0.008

UNCLASSIFIED

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319: <i>Research, Development, Test & Evaluation, Navy / BA 7: Operational Systems Development</i>	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>
---	---

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: 9999: *Congressional Adds*

Congressional Add: *Navy Multiband Terminal Program Interference Mitigation Technology Test*

Congressional Add Subtotals for Project: 9999

Congressional Add Totals for all Projects

	FY 2020	FY 2021
	0.000	9.000
	0.000	9.000
	0.000	9.000

Change Summary Explanation

Beginning in FY22, projects 0728 and 0729 were realigned from Program Element (PE) 0303109N to PE 0604280N due to Program Element consolidation.

Technical:

EHF SATCOM Terminals (Project 0728): No change

The details of program element 0303109N Project 0729 are classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books.

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>
--	---	---

COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
<i>0728: Navy Multiband Terminal (NMT)</i>	0.000	29.932	20.292	0.000	-	0.000	-	-	-	-	-	-
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

Project MDAP/MAIS Code: 290

Note

Funding has been realigned out of PE 0303109N Project 0728 into PE0604280N as part of Program Element Consolidation starting in FY22.

A. Mission Description and Budget Item Justification

The Navy Multiband Terminal (NMT) Program is the required Navy component to the Advanced Extremely High Frequency (AEHF) Program for enhancing protected and survivable satellite communications to Naval forces. Although development of the NMT terminal is complete, software and hardware upgrade development is ongoing to provide enhanced capabilities to the fleet. The NMT system provides an increase in single service capability from 1.5 Megabits per second (Mbps) to 8 Mbps, increases the number of coverage areas, and retains Anti-Jam/Low Probability of Intercept (AJ/LPI) protection characteristics. It is compatible with legacy Navy Low Data Rate/Medium Data Rate (LDR/MDR) terminals and will sustain the Military Satellite Communications (MILSATCOM) architecture by providing connectivity across the spectrum of mission areas, to include land, air and naval warfare, special operations, strategic defense, theater missile defense, and space operations and intelligence. The NMT system replenishes and improves on Navy Military Strategic, Tactical & Relay System (MILSTAR), Defense Satellite Communications System (DSCS), Wideband Global Satellite (WGS), and Global Broadcast Service (GBS) terminal capabilities. The new system equips warfighters with assured, jam resistant, secure communications as described in both the joint AEHF Satellite Communications System and the WGS Operational Requirement Documents (ORD). Mission requirements specific to Navy operations, including threat levels and scenarios, are contained in the ORD. The NMT provides multiband Satellite Communications (SATCOM) capability for ship, submarine, and protected MILSATCOM for shore sites.

The Wideband Anti-Jam Modem System (WAMS) is a Navy technology upgrade that enhances communication capability of shipboard and submarine NMTs by providing wideband Anti-Jam (AJ) Satellite Communication throughput over Wideband Global SATCOM (WGS). WAMS is a major contributor in supporting the National Defense Strategy by investing in resilience to provide assured communications capabilities. WAMS enables space segment Anti Jam (AJ) diversity (EHF/AEHF and WGS), thus enabling NMT ships and submarines equipped with the modem to operate in wideband links closer to threat jammers. The United States USAF (USAF) Protected Tactical Enterprise Service (PTES) program will provide the ground hub component of the WAMS communication system. This PTES joint hub will serve as a DoD enterprise service ground solution for the use of the Protected Tactical Waveform (PTW) of SATCOM communications and introduces a Network Operations Without Shore (NOWS) capability. The NOWS capability will use the Direct Sequence Spread Spectrum (DSSS) waveform that provides uninterrupted communication in case of loss of shore hub connectivity. PTW is a Frequency Hopped Spread Spectrum (FHSS) waveform that provides high data rates in a benign environment and anti-jam protection to meet contested data rate requirements. High data rate anti-jam capability is enabled via the Protected Tactical Waveform (PTW) and low data rate anti-jam capability is provided via the Direct Sequence Spread Spectrum (DSSS) waveform. These two waveforms are designed to operate over the Wideband Global SATCOM system as well as other transponded satellites, and are also forward compatible with the on-board processing capabilities of the future Protected Tactical Satellites (PTS). WAMS enables the use of WGS X and Ka-band resources to assure access to mission critical communications to provide Resilient Command and

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy	Date: May 2021
--	-----------------------

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>
--	---	---

Control (RC2) capabilities in contested/degraded environments, formerly known as Anti-Access/Area Denial (A2AD). The use of WAMS PTW on WGS will augment AEHF Extended Data Rate (XDR) services to provide the information throughput capacity necessary to support critical Command and Control capability.

Navy Global Broadcast System (GBS) is a member of the larger Joint Command, Control, Communications, Computers, and Intelligence (C4I) program, providing high speed (up to 45 Mbps per transponder)/large volume information/data delivery to forces afloat, ashore, and Naval Special Warfare Command. Leveraging the NMT antenna, GBS provides a one-way broadcast to Naval maritime forces across the spectrum of mission areas, to include land, air and naval warfare, special operations, strategic nuclear operations, strategic defense, theater missile defense, and space operations and intelligence in support of RC2. GBS Transmission Security (TRANSEC) is an operational requirement from the Joint GBS ORD and provides robust datalink protection of both uplink and downlink for the GBS broadcast. GBS is evaluating Protected Tactical Waveform (PTW) solutions to meet the TRANSEC mandate. The Air Force & Army Anti-Jam Modem (A3M) and the WAMS are PTW solutions that are under consideration. Navy GBS will require extensive development activities for the new PTW modem solution and must conduct a Follow-On Test & Evaluation (FOT&E) with Joint Services. Overall program efforts include technology insertion studies required to support satellite communications.

B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Title: NMT Resilient C2 Development	22.542	19.642	0.000	0.000	0.000
Articles:	-	-	-	-	-
<p>Description: Navy Multiband Terminal (NMT) software and hardware upgrade development is ongoing to provide Resilient Command and Control (RC2) capabilities to pace the evolving threats to the warfighter in contested/degraded environments. The Wideband Anti-Jam Modem System (WAMS) will provide an anti-jamming capability that will counter various adversary threats. Adaptive Coding (AC) autonomously maximizes throughput in degraded or benign conditions over the Advanced Extremely High Frequency (AEHF) satellites, providing significantly more throughput than is available today in the baseline NMT. The Time of Day (TOD) capability promotes communications reliability and resiliency. When the channel is degraded due to inclement weather or adversarial action, TOD enables the system to automatically transition to a more robust, lower code rate resulting in ability to maintain satellite link thereby allowing the fleet to preserve communications. Technology Insertion, studies and implementation is necessary for military satellite communications systems development to support emerging technologies.</p> <p>FY 2021 Plans: Continue the WAMS development efforts for the design and integration of anti-jam capabilities and Resilient Command and Control (RC2) over Wideband Global Satellite (WGS). The development efforts will configure both the Protected Tactical Waveform (PTW) and Direct Sequence Spread Spectrum (DSSS) waveform capabilities in the modem and allow for seamless transition from benign to contested environments. The DSSS waveform enables anti-jam communications via Network Operations Without Shore (NOWS). Continue</p>					

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy				Date: May 2021	
Appropriation/Budget Activity 1319 / 7		R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>		Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>	
B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)					
development efforts to include requirements such as antenna handover and Automatic Digital Network System (ADNS) capabilities.					
The WAMS vendor will complete critical design reviews including: System Requirements Review (SRR), System Design Review (SDR), Preliminary Design Review (PDR), and Critical Design Review (CDR) to ensure the development efforts are meeting the requirements of the contract. This phase will continue work on the design of the ECU as well as continued support of National Security Agency (NSA) on the certification of the crypto. A MIT Lincoln Labs gold standard hub will be provided to the vendor as Government-Furnished Equipment (GFE) to complete the testing requirements to be interoperable with the Protected Tactical Enterprise Service (PTES) Hub. Start to develop all required training documentation and required Shipmain documentation to install the Engineering Design Model (EDM) modems on identified surface, subsurface and shore facilities to support Development and Operational Testing (DT/OT).					
FY 2022 Base Plans: Funding has been realigned out of PE 0303109N Project 0728 into PE 0604280N as part of Program Element Consolidation starting in FY22.					
FY 2022 OCO Plans: N/A					
FY 2021 to FY 2022 Increase/Decrease Statement: Program decrease is due to realigning funds as part of PE consolidation. FY22 justification and change explanation is provided under PE 0604280N, Project 0728.					
Title: Mobile Advanced Extremely High Frequency (AEHF) Terminal (MAT)					
Articles:					
	6.700	0.000	0.000	0.000	0.000
	-	-	-	-	-
Description: The details of Program Element 0303109N, Project 0728 (MAT) is classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books under new proj 0729					
FY 2021 Plans: The details of Program Element 0303109N, Project 0728 (MAT) is classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books					
FY 2022 Base Plans:					

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>

B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
N/A					
FY 2022 OCO Plans: N/A					
Title: Technology Insertion	0.150	0.150	0.000	0.000	0.000
Articles:	-	-	-	-	-
Description: Overall program efforts include technology insertion studies required to support satellite communications.					
FY 2021 Plans: To maintain alignment with the Navy's Resilient Command and Control (RC2) strategy and approach, Commercial Broadband Satellite Program (CBSP) transitioned from exercising an initial RC2 modem capability to utilizing the Wideband Anti-Jam Modem System (WAMS), which provides protected wideband Satellite Communication (SATCOM) capability to the Fleet. Funds used to perform studies on how to integrate WAMS into the CBSP architecture.					
FY 2022 Base Plans: Funding has been realigned out of PE 0303109N Project 0728 into PE 0604280N as part of Program Element Consolidation starting in FY22.					
FY 2022 OCO Plans: N/A					
FY 2021 to FY 2022 Increase/Decrease Statement: Funding has been realigned out of PE 0303109N Project 0728 into PE 0604280N as part of Program Element Consolidation starting in FY22.					
Title: Global Broadcast System (GBS) Transmission Security (TRANSEC)	0.540	0.500	0.000	0.000	0.000
Articles:	-	-	-	-	-
Description: Navy GBS is a member of the larger Joint C4I program, providing high speed (up to 45 Mbps per transponder)/large volume information/data delivery to forces afloat, ashore, and Naval Special Warfare Command. Leveraging the NMT antenna, GBS provides a one-way broadcast to Naval maritime forces across the spectrum of mission areas, to include land, air and naval warfare, special operations, strategic nuclear operations, strategic defense, theater missile defense, and space operations and intelligence in support of RC2. GBS Transmission Security (TRANSEC) is an operational requirement from the Joint GBS ORD and					

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>

B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
<p>provides robust datalink protection of both uplink and downlink for the GBS broadcast. GBS is evaluating Protected Tactical Waveform (PTW) solutions to meet the TRANSEC mandate. The Air Force & Army Anti-Jam Modem (A3M) and the WAMS are PTW solutions that are under consideration. Navy GBS will require extensive development activities for the new PTW modem solution and must conduct a FOT&E with Joint Services. Overall program efforts include technology insertion studies required to support satellite communications.</p> <p>FY 2021 Plans: In alignment with GBS Executive Agent (USSF) PTW implementation, Navy GBS will continue PTW solution assessment and begin PTW solution studies and design.</p> <p>FY 2022 Base Plans: Funding has been realigned out of PE 0303109N Project 0728 into PE 0604280N as part of Program Element Consolidation starting in FY22.</p> <p>FY 2022 OCO Plans: N/A</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: Program decrease is due to realigning funds as part of PE consolidation. FY22 justification and change explanation is provided under PE 0604280N, Project 0728.</p>					
Accomplishments/Planned Programs Subtotals	29.932	20.292	0.000	0.000	0.000

C. Other Program Funding Summary (\$ in Millions)

Line Item	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
• OPN/3216: NAVY <i>MULTIBAND TERMINAL (NMT)</i>	75.020	55.342	34.723	-	34.723	-	-	-	-	-	-

Remarks

The Other Appropriation represents remaining procurement and installation of NMT production units for Afloat and Shore requirements to reach Full Operational Capability. Funding also includes the procurement and installation of Assured Command and Control (AC2) modems as well as the installation of Advanced Time Division Multiple Access (TDMA) Interface Processors (ATIPs), X/KA Back-Fits, and Ashore Antennas.

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>

D. Acquisition Strategy

The Navy Multiband Terminal (NMT) Follow-On Full Deployment (FOFD) contract will continue NMT production for Afloat platforms and Shore locations, in support of the Chief of Naval Operations and the Department of the Navy (DON), and will allow the NMT Program to complete Full Operational Capability (FOC). The competitive contract awarded to Comtech supports the development of Advanced Time Division Multiple Access (TDMA) Interface Processor (ATIP) and Assured Command and Control (AC2) modem enhancements such as Adaptive Coding. A new competitive contract will be awarded to support development and procurement of the Wideband Anti-Jam Modem System (WAMS).

UNCLASSIFIED

Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>
--	---	---

Product Development (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Software Development Engineering	C/CPFF	NUWC : Newport, RI	0.000	3.067	Jan 2020	0.957	Jan 2021	0.000		-		0.000	-	-	-
Software Development Engineering	WR	NIWC PAC : San Diego, CA	0.000	0.515	Jan 2020	0.464	Jan 2021	0.000		-		0.000	-	-	-
WAMS Design Development	C/CPFF	L3 : San Diego	0.000	10.318	Jul 2020	12.500	Feb 2021	0.000		-		0.000	-	-	-
TRANSEC Development	SS/CPFF	TBD : TBD	0.000	0.000		0.000		0.000		-		0.000	-	-	-
Subtotal			0.000	13.900		13.921		0.000		-		0.000	-	-	N/A

Remarks
 PY Funding under PE 1203109N.
 Funding has been realigned out of PE 0303109N Project 0728 into PE 0604280N as part of Program Element Consolidation starting in FY22.

Support (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Software Integration/ Government Oversight	WR	NUWC : Newport, RI	0.000	1.394	Nov 2019	0.750	Nov 2020	0.000		-		0.000	-	-	-
Software Integration Support	WR	NIWC PAC : San Diego, CA	0.000	0.745	Nov 2019	0.756	Nov 2020	0.000		-		0.000	-	-	-
Software Engineering Support	C/CPFF	SYSTECH : San Diego, CA	0.000	2.163	Nov 2019	0.600	Nov 2020	0.000		-		0.000	-	-	-
WAMS Studies and Design	FFRDC	MIT/LL : Lexington, MA	0.000	0.250	Jan 2020	0.250	Jan 2021	0.000		-		0.000	-	-	-
WAMS Cybersecurity Engineering	WR	NSA : Fort Meade, MD	0.000	0.275	Jan 2020	0.250	Jan 2021	0.000		-		0.000	-	-	-
GBS TRANSEC Engineering Support	WR	NIWC PAC : San Diego, CA	0.000	0.540	Jan 2020	0.500	Jan 2021	0.000		-		0.000	-	-	-
Classified	MIPR	NSMA : San Diego, CA	0.000	5.900	Jan 2020	0.000		0.000		-		0.000	-	-	-

UNCLASSIFIED

Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>
--	---	---

Support (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Subtotal			0.000	11.267		3.106		0.000		-		0.000	-	-	N/A

Remarks
 PY Funding under PE 1203109N.
 Funding has been realigned out of PE 0303109N Project 0728 into PE 0604280N as part of Program Element Consolidation starting in FY22.

Test and Evaluation (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Technology Insertion	WR	COTF : Norfolk, VA	0.000	0.150	Jan 2020	0.150	Jan 2021	0.000		-		0.000	-	-	-
WAMS Development Test and Evaluation	WR	NIWC PAC : San Diego, CA	0.000	2.265	Nov 2019	1.925	Nov 2020	0.000		-		0.000	-	-	-
Subtotal			0.000	2.415		2.075		0.000		-		0.000	-	-	N/A

Remarks
 PY Funding under PE 1203109N.
 Funding has been realigned out of PE 0303109N Project 0728 into PE 0604280N as part of Program Element Consolidation starting in FY22.

Management Services (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Contract Management	C/CPFF	BAH : San Diego, CA	0.000	0.200	Nov 2019	0.182	Nov 2020	0.000		-		0.000	-	-	-
Program Management	C/CPFF	BAH : San Diego, CA	0.000	1.300	Nov 2019	0.958	Nov 2020	0.000		-		0.000	-	-	-
Travel	Various	NAVWAR : Various	0.000	0.050	Nov 2019	0.050	Nov 2020	0.000		-		0.000	-	-	-
Classified	MIPR	NSMA : San Diego, CA	0.000	0.800	Nov 2019	0.000		0.000		-		0.000	-	-	-
Subtotal			0.000	2.350		1.190		0.000		-		0.000	-	-	N/A

UNCLASSIFIED

Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>
--	---	---

Management Services (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			

Remarks
 PY Funding under PE 1203109N.
 Funding has been realigned out of PE 0303109N Project 0728 into PE 0604280N as part of Program Element Consolidation starting in FY22.

	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	0.000	29.932	20.292	0.000	-	0.000	-	-	N/A

Remarks
 PY Funding under PE 1203109N.
 Funding has been realigned out of PE 0303109N Project 0728 into PE 0604280N as part of Program Element Consolidation starting in FY22.

UNCLASSIFIED

Exhibit R-4, RDT&E Schedule Profile: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
SATELLITE LAUNCHES AEHF Launches	✦ SV- 6						
MILESTONES							
DEVELOPMENT	Wideband AJ Modem System (WAMS)						
TESTING		◇ PDR ◇ CDR	◇ TRR	◇ DVT	WAMS Integrat ion &		
PROCUREMENTS	PY10 ◆	PY10+ ◆	SLE-MOD Kits ◇				
NMT DELIVERIES	PY9 ◆	PY10 ◇	PY10+ ◇				
INSTALLATIONS	NMT Terminal Installations						
				SLM I			

Notes: PU 0728 realigned from PE 0303019N to PE 0604280N in FY22
 SLM I: SLE-Mod Installations starting in Q3

UNCLASSIFIED

Exhibit R-4, RDT&E Schedule Profile: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>
--	---	---

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	
MILESTONES DEVELOPMENT TESTING PROCUREMENTS								
	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">TRANSEC Modem Solution Assessment</div>		<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">TRANSEC Modem Studies & Design</div>	<div style="display: flex; align-items: center; justify-content: center;"> <div style="margin-right: 5px;">◇</div> <div style="text-align: left;">Acquire TRANSEC Prototype(s)</div> </div>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">TRANSEC Modem Integrati on & Test</div>			

Notes:
 PU 0728 realigned from PE0303109N to PE 0604280N in FY22
 Transec Modem Integration and Test starts in Q3 FY22

UNCLASSIFIED

Exhibit R-4A, RDT&E Schedule Details: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0728 / <i>Navy Multiband Terminal (NMT)</i>

Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
Proj 0728				
AEHF Launch SV-6	2	2020	2	2020
Wideband Anti-Jam Modem System (WAMS) Development	1	2020	4	2022
WAMS Preliminary Design Review (PDR)	1	2021	1	2021
WAMS Critical Design Review (CDR)	4	2021	4	2021
WAMS Technical Readiness Review (TRR)	1	2022	1	2022
WAMS Design Verification Testing (DVT)	3	2022	3	2022
WAMS Integration & Test	2	2022	4	2022
NMT Procurement Year (PY10)	2	2020	2	2020
NMT Procurement Year (PY11)	2	2021	2	2021
NMT FRP PY9 Delivery	3	2020	3	2020
NMT FRP PY10 Delivery	3	2021	3	2021
NMT Terminal Installations	1	2020	4	2022
Global Broadcast System(GBS) TRANSEC: Transec Modem Solution Assessment	3	2020	1	2022
Global Broadcast System(GBS) TRANSEC: Transec Modem Studies & Design	4	2021	4	2022
Global Broadcast System(GBS) TRANSEC: Transec Prototype	2	2022	2	2022
Global Broadcast System(GBS) TRANSEC: Transec Integration & Test	3	2022	4	2022

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy										Date: May 2021		
Appropriation/Budget Activity 1319 / 7					R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>				Project (Number/Name) 0729 / <i>Mobile Advanced Extremely High Frequency (AEHF) Terminal (MAT)</i>			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
0729: <i>Mobile Advanced Extremely High Frequency (AEHF) Terminal (MAT)</i>	0.000	0.000	21.686	0.000	-	0.000	-	-	-	-	-	-
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

Project MDAP/MAIS Code: 290

Note

Funding has been realigned out of PE 0303109N Project 0729 into PE0604280N as part of Program Element Consolidation starting in FY22.

A. Mission Description and Budget Item Justification

The details of Program Element 0303109N, Project 0729 are classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books.

B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Title: Mobile Advanced Extremely High Frequency (AEHF) Terminal (MAT)	0.000	21.686	0.000	0.000	0.000
Articles:	-	-	-	-	-
FY 2021 Plans: The details of Program Element 0303109N, Project 0729 are classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books.					
FY 2022 Base Plans: Funding has been realigned out of PE 0303109N Project 0729 into PE 0604280N as part of Program Element Consolidation starting in FY22. The details of Program Element 0303109N, Project 0729 are classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books.					
FY 2022 OCO Plans: N/A					
FY 2021 to FY 2022 Increase/Decrease Statement: Program decrease is due to realigning funds as part of PE consolidation. FY22 justification and change explanation is provided under PE 0604280N, Project 0729.					

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0729 / <i>Mobile Advanced Extremely High Frequency (AEHF) Terminal (MAT)</i>

B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
The details of Program Element 0303109N, Project 0729 are classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books.					
Accomplishments/Planned Programs Subtotals	0.000	21.686	0.000	0.000	0.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

The details of Program Element 0303109N, Project 0729 are classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books.

UNCLASSIFIED

Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0729 / <i>Mobile Advanced Extremely High Frequency (AEHF) Terminal (MAT)</i>
--	---	--

Product Development (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Classified	TBD	Not Specified : Not Specified	0.000	0.000		21.686	Feb 2021	0.000		-		0.000	-	-	-
Subtotal			0.000	0.000		21.686		0.000		-		0.000	-	-	N/A

Remarks

- Funding has been realigned out of PE 0303109N Project 0729 into PE 0604280N as part of Program Element Consolidation starting in FY22.
- The details of Program Element 0303109N, Project 0729 are classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books.

	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	0.000	0.000	21.686	0.000	-	0.000	-	-	N/A

Remarks

- Funding has been realigned out of PE 0303109N Project 0729 into PE 0604280N as part of Program Element Consolidation starting in FY22.
- The details of Program Element 0303109N, Project 0729 are classified SECRET//NOFORN and are submitted to Congress in the classified budget justification books.

UNCLASSIFIED

Exhibit R-4, RDT&E Schedule Profile: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0729 / <i>Mobile Advanced Extremely High Frequency (AEHF) Terminal (MAT)</i>
--	---	--

Proj 0729	FY 2020				FY 2021				FY 2022				FY 2023				FY 2024				FY 2025				FY 2026							
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q				

2022OSD - 0303109N - 0729

UNCLASSIFIED

Exhibit R-4A, RDT&E Schedule Details: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 0729 / <i>Mobile Advanced Extremely High Frequency (AEHF) Terminal (MAT)</i>

Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
Proj 0729				
Classified (Place Holder)	1	2021	4	2022

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy										Date: May 2021		
Appropriation/Budget Activity 1319 / 7					R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>				Project (Number/Name) 9999 / <i>Congressional Adds</i>			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
9999: <i>Congressional Adds</i>	0.000	0.000	9.000	0.000	-	0.000	-	-	-	-	-	-
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

Congressional Add provides for the development, test and evaluation of enhanced capabilities for the Navy Multiband Terminal (NMT) by furthering Science & Technology (S&T) research and transition activities associated with resilient communications capabilities. Specifically, this funding will provide for technology testing, evaluation, demonstration and validation for an interference canceller for Wideband Satellite Communications (SATCOM), modular hardware open platform for wideband SATCOM interface mitigation, an all-digital Multiple Access Waveform (MAW) modem, and study neuromorphic signal processing as the means to support the modernized NMT program, NMT-X.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2020	FY 2021
Congressional Add: Navy Multiband Terminal Program Interference Mitigation Technology Test	0.000	9.000
FY 2020 Accomplishments: N/A		
FY 2021 Plans: The Congressional additions to the NMT program will fund the Science & Technology (S&T) projects for NMT-X, which are broken in to the following 4 tasks:		
Contractor will further enhance the previously developed Modem Hardware Open Platform (MHOP) system by performing the following subtasks: develop ANSI VITA 46 compliant system for MHOP; integrate Radio Frequency System on Chip (RFSoc) into the VPX chassis to host the Digital Conversion System (DCS) and Wideband Signal Processor (WSP) functionality; and implement digital intermediate frequency interface per "VITA 49.2 Digital IF ICD v2.0" data plane standard.		
Contractor will productize Envistacom's Multiple Access Waveform (MAW) Direct Sequence Spread Spectrum (DSSS) waveforms for All Digital Modem (ADM). The contractor shall optimize the performance of the synchronization loops (carrier, chip & symbol), minimize acquisition times, and achieve BER vs C/N performance prescribed in the DVB-S2X standard. The contractor shall add Adaptive Uplink Power Control (AUPC) to the DSSS Productization, by developing a closed loop power control algorithm, developing overhead channel or in-band signaling for conveying AUPC messages and developing "real-time" or close to real-time power control through Monitoring & Control (M&C) Host Application. The contractor shall demonstrate the MAW DSSS Productization.		

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 9999 / <i>Congressional Adds</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021
Contractor will acquire, Verify, and Perform Initial Integration of IES in to WAM. At a minimum, the contractor will evaluate iDirect's CSIR, BAE Systems' Wideband SATCOM Interference Cancellation (WSIC), L3Harris' Gatekeeper, and digital segment of MagiQ's Agile Interference Mitigation System (AIMS).		
The contractor will investigate the efficacy and maturity of utilizing RF photonics and neuromorphic computing for advanced signal processing and analysis. At a minimum, the contractor shall determine the means of applying biological neuromorphology to advance the state of the art for Machine Learning (ML) with specific emphasis on photonics based artificial neural networks.		
Congressional Adds Subtotals	0.000	9.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 9999 / <i>Congressional Adds</i>
--	---	--

Product Development (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Product Development	Various	TBD : TBD	0.000	0.000		8.400	Jun 2021	0.000		-		0.000	-	-	-
Subtotal			0.000	0.000		8.400		0.000		-		0.000	-	-	N/A

Support (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Engineering Support Services	WR	NIWC PAC : San Diego, CA	0.000	0.000		0.300	Mar 2021	0.000		-		0.000	-	-	-
Subtotal			0.000	0.000		0.300		0.000		-		0.000	-	-	N/A

Test and Evaluation (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Testing	WR	NIWC PAC : San Diego, CA	0.000	0.000		0.300	Mar 2021	0.000		-		0.000	-	-	-
Subtotal			0.000	0.000		0.300		0.000		-		0.000	-	-	N/A

	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	0.000	0.000	9.000	0.000	-	0.000	-	-	N/A

Remarks

UNCLASSIFIED

Exhibit R-4, RDT&E Schedule Profile: PB 2022 Navy **Date:** May 2021

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 9999 / <i>Congressional Adds</i>
--	---	--

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
DEVELOPMENT							
			MHOP Enhancements & Modifications				
			ADM Development				
			IES Solutions				
			Signal Processing				
TESTING			Test And Evaluation				

Notes:

UNCLASSIFIED

Exhibit R-4A, RDT&E Schedule Details: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0303109N / <i>Satellite Communications (SPACE)</i>	Project (Number/Name) 9999 / <i>Congressional Adds</i>

Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
Proj 9999				
Congressional Add NMT: MHOP Enhancements and Modifications	3	2021	4	2022
Congressional Add NMT: ADM Development	3	2021	4	2022
Congressional Add NMT: IES Solutions	3	2021	4	2022
Congressional Add NMT: Signal Processing	3	2021	4	2022
Congressional Add NMT: Test and Evaluation	3	2021	4	2022