



Science & Technology Organization
Collaboration Support Office
Platform Systems and Technology (PST)¹ Scientific and Technical Committee (STC)

AVT-SAS-HFM-SET-421 Research Specialists' Meeting (RSM)

on

Platform Digital Twins for Prognostic Health Management and Battle Damage Assessment

Kemer (Antalya), Türkiye

3-5 November 2026

This RSM is open to NATO Nations and NATO STO's Science & Technology Enhanced Partnership Nations (Australia, Japan, Republic of Korea, Switzerland and Ukraine)

Theme-Meeting Objective

This Research Specialists' Meeting will be held in conjunction with the 1st PST STC Meeting Week, with the objective to explore innovative/revolutionary Platform Digital Twin (PDT) technologies that improve military fleet sustainment and readiness to:

- Increase platform Operational Availability by enabling better maintenance planning and reducing the occurrence of unanticipated damage findings;
- Ensure platform readiness and safety by providing the warfighter with better information on the condition of each asset;
- Reduce maintenance and logistics costs by reducing both unnecessary maintenance and unplanned maintenance; and
- Optimize the ability of military platforms to recover from casualty scenarios.

The specific objectives of the AVT-SAS-HFM-SET-421 RSM are to:

- Review state-of-the-art of digital twin technology development and the benefits of various digital twin outputs; and
- Explicitly intend to focus on the application of these technologies to the operational phase of tri-service military platforms.

^{1 1} Previously known as the **Applied Vehicle Technology (AVT) Panel** before 01 July 2026.

Topics to be covered

The topics cover the maritime, air, land, space and medical domains in the technical areas of:

Strategy and Implementation of Platform Digital Twins

- PDT Development Methodologies
- Optimized Control of Systems
- PDT Architectures – Sparse and Virtual Sensing, Multi-Modal Sensing Telemetry, Wireless Sensing, Edge Computing, Data Management, Continuous and Autonomous Monitoring Systems, Low Bandwidth Secure Communications in Contested Environments
- PDT Algorithms – Data Fusion, Machine Learning (ML) and Feature Reduction for Operational Data Sets, Algorithmic Approaches for Measured Data, Fusion of Data with Models, Operationalization of AI/ML Algorithms
- PDT Adaptations Integrating Complex Environmental Data
- Human Systems Integration, Human Machine Interfacing
- Uncertainty Analysis and Propagation
- Trust in Artificial Intelligence

Prognostic Health Management

- Predictive Capabilities to Assess Future Performance of Platform Structures and Systems
- Structural Health Monitoring for Service Life Extension
- Predictive Analytics for Hull, Mechanical and Electrical (H&ME) Systems
- Remaining Useful Life Estimation
- Integration of Data, Physics and Environmental Models
- Extending Prognostications
- Warfighter Readiness

Battle Damage Assessment

- Platform Recoverability
- Residual Capability Assessment
- Use of data at order-of-magnitude different spatial and temporal scales

Background

In recent years there have been increasing R&D activities focusing on digital twin technology development in North American and European NATO countries. Most recently, the AVT-369 Research Symposium 'Digital Twin Technology Development and

Application for Tri-Service Platforms and Systems' effort concluded at the 52nd NATO AVT Business Panel Meeting in Båstad, Sweden (October 2023). Several themes ran through the symposium. These were:

- Digital Twins are expected to be beneficial,
- Condition monitoring and predictive maintenance of a physical system are a good application,
- Continued access to physical data and model results is necessary, and
- User requirements are important.

The AVT-369 Technical Evaluator Report also recommended 'that PST convene a specialist workshop on Digital Twin applications to gather more information on best practices in the development, execution, and maintenance of Digital Twins'. This will enable the AVT Digital Twin community to better decide where to focus their attention.'

AVT-369 RSY representatives from USA, CAN and NLD have since convened and discussed potential focus areas for a follow-on AVT Digital Twin Technical Activity. To better focus this effort and to achieve tangible objectives, the military platform operational phase has been chosen as the digital twin application in a platform's lifecycle (henceforth referred to as 'Platform Digital Twin' or PDT). PDT is thus differentiated by digital twins that may be useful in modelling and simulation, platform design or manufacturing. Furthermore, two specific PDT use cases have been identified for additional topic refinement:

- Prognostic Health Management (PHM) - PHM is a predictive analytics extension of Condition Based Maintenance (CBM) enabled by data science, Machine Learning (ML) and other emerging technologies. Whereas CBM efforts can result in maintenance recommendations based on 'as is' performance, PHM efforts can result in proactive preventative maintenance recommendation based on 'to be' performance predictions. PHM can be enhanced via root cause analyses and Remaining Useful Life (RUL) estimation.
- Battle Damage Assessment (BDA) - From a digital twin perspective, BDA encompasses the ability of a platform to organically assess the incidence and severity of degradation or failure of critical platform structures, systems and/or personnel resulting from a casualty scenario. BDA may include consequence localization, decision space definition, reactive and proactive mitigation, the optimization of warfighting readiness, or ensuring the highest probability of assistance or rescue.

There is a need to evaluate and mature state-of-the-art of digital twin technology development, benefits of various digital twin outputs, and digital twin applications related to platform operational availability.



Registration

Online registration for the AVT-SAS-HFM-SET-421 RSM is mandatory for all meeting participants, programme committee members, authors, presenters and external guests. Participation is free of charge. Due to security restrictions, only duly registered and approved participants will have access to the General Information Package (GIP). Once your registration is approved by the PST Executive Office, you will receive a **confirmation email** along with the GIP, which includes detailed information on the conference location and logistics.

In addition to your online registration, you will need to visit the registration desk on-site prior to the meeting to collect your badge. Please note that AVT-SAS-HFM-SET-421 will begin at 8:45AM on November 3rd, 2026. It is highly recommended that participants arrive early at the meeting venue to collect their badge at the registration desk.

The registration desk location and hours for all the days of the event will be available in the provided GIP.

To register for the event, please head here:

[Homepage - NATO STO 1st PST STC Meeting Week](#)

The registration deadline is on October 4th, 2026. Due to logistical constraints, late registrations will not be accepted.

Eligibility and Participation

Participants are reminded to verify their eligibility based on their nationality before registering for the event. The AVT-SAS-HFM-SET-421 RSM is open to citizens from NATO Nations, Australia, Japan, Republic of Korea, Switzerland and Ukraine.

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PROGRAMME

DAY 1

Tuesday, November 3rd, 2026, 09:00 – 17:30

Session 1		Platform Digital Twins for Prognostic Health Management and Battle Damage Assessment
Chair:	Dr. Michael Robert, NSWCCD, USA	
09:00	0	AVT-SAS-HFM-SET-421 RSM Welcome and Overview Dr. Michael Robert, NSWCCD, USA
09:30	KN1	The development of Maritime Digital Twins and Applications – Strategy and Case Study Mr. Joshua Barnes, NRC, CAN
10:30	COFFEE BREAK	
Session 2		Strategy and Implementation of Platform Digital Twins
Chair:	Mr. Marcel Bos, NLR, NLD	
11:00	0	Platform Digital Twin Collaborative Demonstration of Technology Dr. Michael Robert, NSWCCD, USA
11:30	1	A Sensitivity-enhanced Structural Health Monitoring Methodology for Robust and Informative Prognostic Health Management (PHM) and Battle Damage Assessment (BDA) Dr. Harry Millwater, UTSA, USA
12:00	2	Development and Demonstration of a Probabilistic Digital Twin Framework for Helicopter Safe-Life Assessment Mr. Guillaume Renaud, NRC, CAN
12:30	LUNCH	
Session 3		Strategy and Implementation of Platform Digital Twins (cont.)
Chair:	Dr. Min Lao, NRC, CAN	
14:00	3	Leveraging the NATO Generic Vehicle Architecture as a Backbone for Platform Digital Twins in Ground Combat Systems

		Mr. Yannic Schlimpen Fraunhofer, DEU
14:30	4	Enhancing Damage Reports and Downtime Prediction with Digital Twin Technology and AI Mr. Hendrik Meyer, DLR, DEU
15:00	5	Between data sovereignty and system availability: the tension between limited data access and comprehensive data utilisation for predictive maintenance in aviation Mr. Hendrik Meyer, DLR, DEU
15:30		COFFEE BREAK
Session 4 Chair:		Strategy and Implementation of Platform Digital Twins (cont.) Dr. Benjamin Grisso, NSWCCD, USA
16:00	6	Data-driven and Numerical Analysis of Ship Motions and Structural Loads for Virtual Fleet Monitoring Dr. Remco Hageman, Marin, NLD
16:30	7	Stochastic Fatigue Analysis Framework for Risk-Informed Maintenance of Naval Vessels Dr. Nicholas Silionis, National Technical University of Athens, GRC
17:00	8	Real-Time Platform Condition Awareness as a Foundation for Prognostic Health and Uncertainty Assessment Mr. Matthias Buderath, Linova Software, DEU

DAY 2

Wednesday, November 4th, 2026, 09:00 – 17:30

Session 1 Chair:		Predictive Capabilities to Assess Future Performance of HM&E Systems Dr. Michael Robert, NSWCCD, USA
09:00	KN2	Insight to Action: A Blueprint to Understand, Predict and Manage Fleet Condition

10:00	9	Platform Energy Digital Twin Testbed for Prognostic Health Management and Battle Damage Assessment of Naval Power Systems The development of Maritime Digital Twins and Applications – Strategy and Case Study Dr. Kerry Sado, University of South Carolina, USA
10:30		COFFEE BREAK
Session 2 Chair:		Predictive Capabilities to Assess Future Performance of HM&E Systems (cont.) Dr. Michael Robert, NSWCCD, USA
11:00	10	Prognostic and Health Management for marine engine applications: from the theoretical basis to a real-life software application Giuseppe Giannino, Isotta Fraschini Motori S.p.A., ITA
11:30	11	Machine Learning-Enhanced Co-Simulation Framework for Predictive Battery Degradation Modeling in Naval Energy Systems Dr. Mortiz Braun, DLR, DEU
12:00	12	Identification of AE background noise of ship vessel operation and integration of damage evolution AE signals for effective structural health monitoring in vessel structures Dr. Vasilios Kappatos, Hellenic Institute of Transport, GRC
12:30		LUNCH
Session 3 Chair:		Assessment and Predictive Capabilities to Increase Platform Recoverability Dr. Mortiz Braun, DLR, DEU
14:00	13	Impact detection and localization on naval ship hulls Jan Willem Wiegman, NLR, NLD
14:30	14	A High-Fidelity Platform Digital Twin for Mission-Oriented Prognostic Health Management and Battle Damage Assessment Mr. Jacopo Bardiani, Polimi, ITA
15:00	16	Decision-support framework to minimize collapse risk in damaged ship return missions

Ms. Anastasia Valma, National Technical University of Athens,
GRC

15:30

COFFEE BREAK

Session 4

Chair:

Cross-Panel Platform Digital Twin Topics

Dr. Mortiz Braun, DLR, DEU

Sensors and Electronic Technology for Platform Digital Twins

16:00

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Detection & Classification of Faulty Accelerometer Readings via
Machine Learning

Dr. Johnathan Sterling, NSWCCD, USA

Human Factors and Medicine for Platform Digital Twins

16:30

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Unified Sensing and Human Performance Modeling for Ship
Emergency Response

Dr. Liming Salvino, Duke University, USA

Systems Analysis and Studies for Platform Digital Twins

17:00

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Concept design of an acoustic signature predictive module for
full-scale monitoring

Mr. Paolo Becchi, CETENA S.p.A., ITA

DAY 3

Thursday, November 5th, 2026, 09:00 – 12:30

Session 1

Chair:

Cross-Panel Platform Digital Twin Topics (cont.)

Dr. Daniel Norrison, DSTG, AUS

Systems Analysis and Studies for Platform Digital Twins (cont.)

09:00

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Platform Digital Twinning via Dynamic Mode Decomposition:
Application to CNR R/V Gaia Blu and 5415M Naval Destroyer
Model

Dr. Riccardo Pellegrini, CNR, ITA

09:30 **TE TECHNICAL EVALUATOR SUMMARY**

10:30 **COFFEE BREAK**

Session 2 RSM Discussion and Closure

11:00 --- Room available for Q&A, sidebars, etc.

12:30 **LUNCH**

Science and Technology Organization in NATO

In NATO, Science & Technology (S&T) is defined as the selective and rigorous generation and application of state-of-the-art, validated knowledge for defence and security purposes. S&T activities embrace scientific research, technology development, transition, application and field-testing, experimentation and a range of related scientific activities that include systems engineering, operational research and analysis, synthesis, integration and validation of knowledge derived through the scientific method.

In NATO, S&T is addressed using different business models:

- The Collaborative business model where NATO provides a forum where NATO Nations and partner Nations elect to use their national resources to define, conduct and promote cooperative research and information exchange.
- The In-House delivery business model where S&T activities are conducted in a NATO dedicated executive body, having its own personnel, capabilities and infrastructure.

The Science and Technology Organization - STO

The mission of the NATO STO is to help position the Nations' and NATO's S&T investments as a strategic enabler of the knowledge and technology advantage for the defence and security posture of NATO Nations and partner Nations, by:

- Conducting and promoting S&T activities that augment and leverage the capabilities and programmes of the Alliance, of the NATO Nations and the partner Nations, in support of NATO's objectives;
- Contributing to NATO's ability to enable and influence security - and defence-related capability development and threat mitigation in NATO Nations and partner Nations, in accordance with NATO policies;

- Supporting decision-making in the NATO Nations and NATO.

AVT-SAS-HFM-SET-421 Research Specialists' Meeting (RSM)

Acknowledgement

The Applied Vehicle Technology Panel expresses its thanks to Türkiye for the invitation to hold this meeting in Antalya and for the facilities and personnel, which make this meeting possible.