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Thank you for participating,

Gregory Hamilton
President
Aviation Week Network

Acknowledged, agreed, and submitted by

Nominee's Signature

5/25/2022
Date

Nominee's Name (please print): Mukesh Kumar

Title (please print): Program Director

Company (please print): Honeywell Aerospace

NOMINATION FORM

Name of Program: Micro Vapor Cycle System (MicroVCS)

Name of Program Leader: Mukesh Kumar

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☐ Customer Approved

- Date: N/A
- Customer Contact (name/title/organization/phone): N/A

☐ Supplier Approved (if named in this nomination form)

- Date: N/A
- Supplier Contact (name/title/organization/phone): N/A

PLEASE REFER TO PROGRAM EXCELLENCE DIRECTIONS
AS YOU COMPLETE THIS FORM.

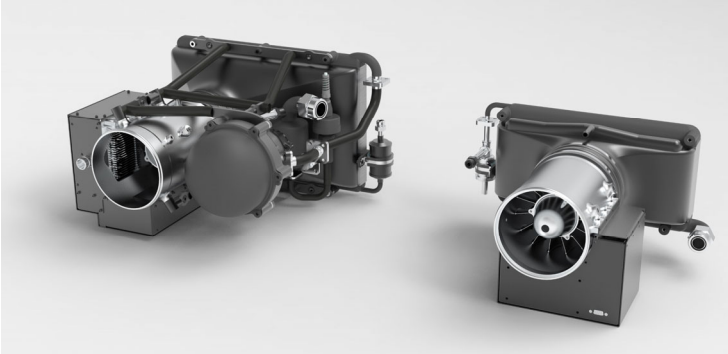
EXECUTIVE SUMMARY: Make the Case for Excellence *(Value: 10 pts)*

What is the vision for this program/project? What unique characteristics and properties qualify this program for consideration? (12 pt. Times New Roman) LIMIT YOUR NARRATIVE TO THIS PAGE.

Honeywell's Micro Vapor Cycle System (MicroVCS) is a lightweight, low-maintenance and energy-efficient thermal management system. It uses advanced technology such as a high-speed centrifugal compressor, next generation refrigerant and power electronics with Silicon Carbide switches, to generate cold air or liquid that can be used to cool heat-generating electronic components, batteries, and the cockpits and cabins. The new system is the ideal cooling solution for emerging electric vertical takeoff and landing applications like urban air mobility aircraft and military & civil helicopters where reduced size and weight are priorities.

Today's aircraft vapor cycle systems comparable to the MicroVCS are heavier and oil-based, while also requiring periodic maintenance. This can contribute to aircraft being out of service - a challenging dynamic when aircraft are expected to be available on-demand, take off, and land dozens of times each day. Our innovative MicroVCS is up to 35 percent lighter and 20 percent more efficient than conventional vapor cycle systems with comparable cooling capacity. The system is highly reliable and virtually maintenance free, thanks to its unique oil-free technology and small number of moving parts, resulting in low total cost of ownership. The Honeywell VCS design experience is based on mature, fielded units that have performed reliably in demanding environments such as the Airbus A350, Boeing 707, F-22 and E2-C/D. Our product comes with Honeywell's Forge – Connected Maintenance, a solution for health monitoring and predictive analytics to minimize operating costs and downtime.

Micro VCS Condenser and Evaporator Fan Assembly



The MicroVCS program team reduced product development cycle time from 48-months to 24-months while simultaneously reducing R&D investment by 30 percent through application of Product Line Engineering and Scaled Agile principles to the complex systems development. Honeywell successfully adapted Agile practices to a large, integrated system that includes parallel development of multiple sub-assemblies, including both software and hardware. Honeywell overcame the known challenges of applying Agile to hardware development, by deploying Scaled Agile to manage integrated features across teams. To achieve this, Honeywell utilized new and novel tools, adapted organizational constructs and challenged the long held belief that waterfall style program management is necessary for hardware programs. This bold new management style, coupled with Honeywell's innovative Product Line Engineering approach is key to providing additional design flexibility and responsiveness for our customers resulting in more efficient programs and better product solutions.

Honeywell is actively working with several UAM market innovators to apply the MicroVCS technology in their advanced air mobility (AAM) platforms. Using Agile development methodologies, Honeywell has been able to incorporate much of the feedback received from the customer and supplier partners in the design thereby making the system mature and ready for deployment.

Do not exceed 10 pages in responding to the following four descriptions; allocate these 10 pages as you deem appropriate, but it is important that you respond to all four sections. DO NOT REMOVE THE GUIDANCE PROVIDED FOR EACH SECTION.

VALUE CREATION *(*Value: 15 pts*)*
Please respond to the following prompt:

- Clearly define the value of this program/project for the corporation

The MicroVCS program is a Breakthrough Initiative (BTI) for Honeywell Aerospace with potential of creating significant contribution to the overall Honeywell financials, with a market size estimated at USD 4B. The MicroVCS project team is leading the way in Honeywell Aerospace for implementation of Agile methodologies and Product Line Engineering for complex mechanical hardware and software programs. The team has been able to develop the processes and mechanisms for executing Agile while keeping the scope and budget in control. Team members trained in the MicroVCS programs can cross pollinate the Agile culture across other programs in Honeywell Aerospace thereby delivering significant savings for the corporation – "doing more for less".

To maximize flexibility for our customers, the MicroVCS system was developed with a Product Line Engineering approach, where the system was decomposed into key components, features and variants. This innovative building block approach was developed with a scalable architecture using advanced tools to enable future expansion and re-use across Aerospace. The MicroVCS program is spearheading this Product Line Engineering approach within Aerospace – driving the future of advanced, adaptable re-use in Aerospace systems development.

Execution is planned in a way that higher risk components are developed earlier in the program followed by development of the relatively lower risk derivatives with some overlap. This helped compress the schedule for the entire product line by 50 percent and cost by 30 percent.

- Clearly define the value of this program/project to your customer

The MicroVCS is highly integrated with the customer's aircraft perimeter, where each customer application has unique interface, installation and cooling requirements. Honeywell designed the MicroVCS system with maximum flexibility in mind, to meet the diverse needs of our customers. A more rigid 'off the shelf' solution, would result in costly customer-funded updates to either the aircraft perimeter or the core system to manage the integration. To solve this, Honeywell's Product Line Engineering approach decomposes the system into core components and features and uses advanced tools to synthesize and manage unique system variants. This framework enables flexible MicroVCS solutions adapted to the unique customer requirements, for the price of 'off the shelf'.

The MicroVCS team prioritized the development of more complex components like the Compressor, Fan Assembly, Controllers and the related software and controls as part of the core program. The Core components were developed with a superset of features, to enable flexibility for different applications. The remaining components such as heat Exchangers, ducting, frame, and others will be developed as part of the customer / application program. Utilizing a Product Line Engineering approach, each component and its varying features will be added to a baseline library to be reused on multiple customer programs. This baseline library will then allow for a selection of components/sizes to meet the needs of each different customer allowing for maximum reuse of components and lower development times for customers. Using this approach, the customer application schedule can be reduced from a typical 3-4 year

cycle time to less than 18 months. It also provides highly mature products at significantly lower cost to the customers which can be passed on to the end customers enabling the price sensitive Urban Mobility Market.

- Clearly define the value of this program/project to members of your team

The MicroVCS team members benefit by working on a project that is on the forefront of Aerospace technology, in the exciting Advanced Air Mobility (AAM) market space. Team members have the chance to think "outside the box" to come up with innovative system designs and processes. Working with potential customers and suppliers gives team members a unique opportunity to understand the vision for the product while also designing for manufacturability to ensure the MicroVCS will meet customer demands.

Honeywell recognizes the value of Agile methodologies in executing a development program, and team members on this program have benefitted in several ways. Gaining experience from the well-defined roles like Scrum Master or Product Owner and conducting the disciplined approach of daily scrum meetings, Sprint planning, and Sprint retrospectives are highly sought-after skills in their next roles. This has also resulted in pride of ownership in the program and the product. As the team members execute this program, they are becoming experts on the best way to manage an agile program on highly regulated hardware. They can now coach others on future teams to drive further program excellence.

MicroVCS is one of the most coveted programs in Honeywell Aerospace with visibility from highest levels of leadership at Honeywell Aerospace and Honeywell International. Members of this program are well positioned for continued career growth as a result of this program experience.

- Clearly define the contribution of this program/project to the greater good (society, security, etc.)

(12 pt. Times Roman)

MicroVCS offers a lightweight, low-maintenance, lower Global Warming Potential (GWP) and lower cost cooling option for the Advanced Air Mobility (AAM) market. One of the key applications of this system is cooling for the rapidly expanding Advanced Air Mobility (AAM) and Electric Vertical Takeoff and Landing (eVTOL) aircraft market, where every ounce of weight counts. In traditional aircraft environmental control systems, cooling is provided via an air cycle machine, which is powered by bleed air from the engine. With the transition to energy-efficient, electric aircraft, bleed air is not available, thus a different approach for aircraft cooling is required, like MicroVCS. This cooling solution is an enabler for the AAM market's transition to clean energy and will reduce the carbon footprint of this sector.

MicroVCS uses a new refrigerant, Solstice R1233-zd, which has 300X lower Global Warming Potential than the traditional refrigerant R-134 for similar cooling systems. With governments around the world moving towards legislation requiring steps to reduce usage of higher GWP products, usage of R1233-ZD in MicroVCS is a step in the right direction to meeting international treaties to limit global warming.

AAMs will also change the way we commute for work or pleasure. Currently people live within 10 to 30 miles of work with an average commute time of an hour, which causes overcrowding of cities and stresses the infrastructure. AAMs will enable people to move out 50 to 100 miles from work, with a similar commute time to today. A lower weight and cost cooling solution, like MicroVCS, is a critical enabler for this societal transition.

METRICS (Value: 15 pts)

Please respond to the following prompt:

- What are your predictive metrics?

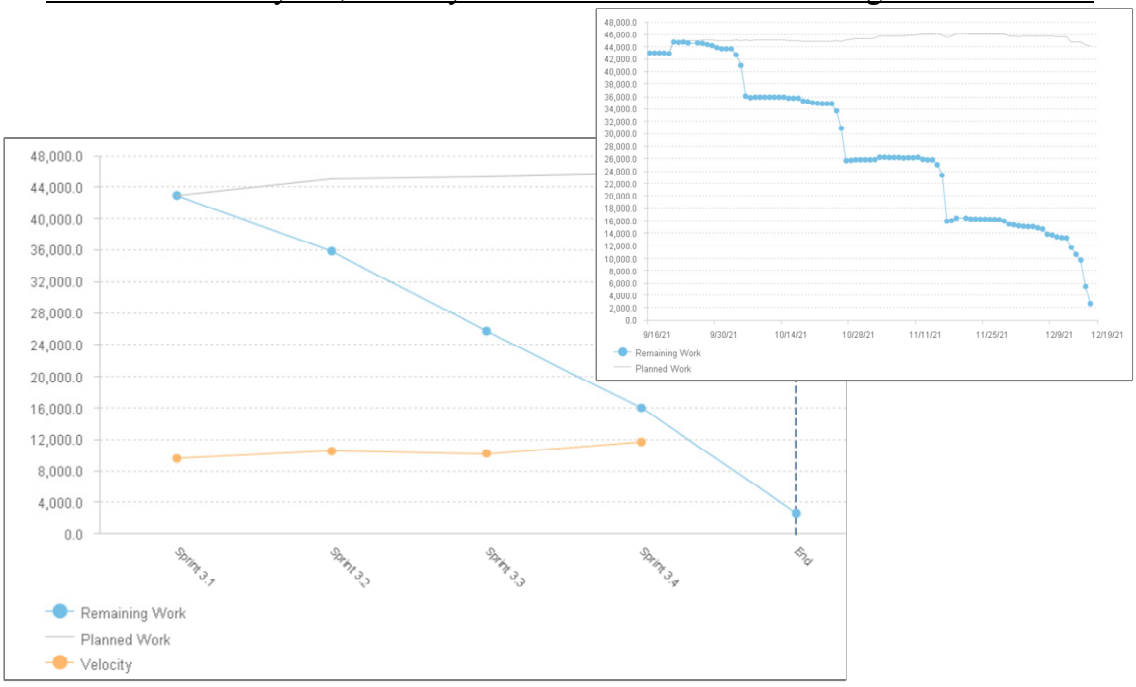
To manage the large, integrated development program, the MicroVCS team adopted Scaled Agile Framework, with an Agile Release Train consisting of 12 scrum teams. To ensure coordination and dependency-handoff, the program team held a detailed Program Increment planning session every 3 months, where the key System Features were prioritized and decomposed into stories across the 12 teams. The teams then worked to 3-week Sprints, with a short Sprint planning session at the start of each one, to plan the stories for a given team. Upon completion of the various planning activities, Agile metrics were used to predict and measure team performance. Say/Do and Velocity for the Program Increments and Sprints were monitored at both the Scrum Team and Program Team level. The Say/Do ratio is the ratio of work accomplished during an iteration (e.g. Sprint) to the work each team committed to at the start of an iteration. The target Say/Do ratio for each Sprint is 90-110%. The team Velocity measures the quantity of work for a given iteration, where future Velocity is predicted based on past performance. Team Velocity is monitored each Sprint to guide staffing and resource decisions. In addition to agile metrics, the team utilized program milestones for key deliverables, to ensure critical program enablers and features were on track. The team was expected to meet all Category 1 milestones on time (100%).

- How did you perform against these metrics?

The MicroVCS program has successfully met all Category 1 milestones on time and has performed well against the target agile metrics. For the overall program team, the average Say/Do ratio is 94% and the average velocity is 10,000 hours per Sprint.

For example, Program Increment 3 was planned with a Say of 43,000 hours and ended with a Velocity of 42,074 hours, resulting in a Say/Do of 98%. See chart below.

Team Metrics: Say/Do, Velocity and Release Burndown for Program Increment 3



- How do your predictive metrics drive action toward program excellence? Please provide examples.

(12 pt. Times Roman).

The Scaled Agile Framework planning process and associated predictive agile metrics, enabled the MicroVCS team to pivot seamlessly when internal or customer feedback resulted in changes to the design and/or priorities. The team decomposed the system into core Features, and then prioritized and planned those Features for a given Program Increment, taking into consideration the estimated scope of the Features and the known team Velocity. Given the volatility of this emerging market, there were many times when a sudden change in program priority or technical design drove updates to the plan. When this volatility occurred, the team had to pivot to prioritize a different system component, feature or variant. The Agile planning tools and predictive metrics (Velocity) enabled a quick impact assessment and facilitated seamless reprioritization and planning of the Features and associated Stories.

In addition to agility, the predictive metrics were critical to ensuring appropriate staffing, resource allocation and other enablers were maintained, via monitoring of Team Say/Do and Velocity. At times, certain teams would have a lower Velocity and Say/Do than anticipated. When this occurred, the root cause was established during Sprint retrospective reviews, at which point the program manager or resource managers would take action to address key enablers (e.g. shifting additional resources to reinforce the team).

DEALING WITH PROGRAM COMPLEXITY (VOLATILITY, UNCERTAINTY, COMPLEXITY, AMBIGUITY, OR VUCA) *(*Value: 25 pts*)*

Please respond to the following prompts:

- *10 pts:* Describe areas of VUCA faced by your program and why.

A significant challenge with designing a core MicroVCS platform, is the necessary and complex integration with the aircraft perimeter. Each customer aircraft has unique interface (digital, electrical and mechanical) and cooling requirements, driving substantial volatility and customization into the System design and controls. While developing the core MicroVCS platform, these customer-driven constraints are not known, leading to ambiguity and adding complexity to the core design. To further complicate the problem statement, Advanced Air Mobility is one of the key application areas for the MicroVCS program, which is an emerging market with volatile customer requirements.

To manage the ambiguity and complexity, the MicroVCS program deployed an agile development methodology, which was an uncertain process. At the time, no Honeywell Aerospace team had successfully deployed Agile on a large, integrated system with parallel development of mechanical hardware, electronic hardware and electronic software, which needed to meet aircraft certification standards.

In addition to the technical complexity, the MicroVCS program faced further headwinds as a result of the Pandemic, including resource attrition, a dynamic financial situation and supply chain challenges.

- *15 pts:* Explain how your team responded to these challenges.

(12 pt. Times Roman)

To solve the challenge regarding the diverse and volatile customer applications and interface requirements, the MicroVCS platform embraced an advanced Product Line Engineering (PLE) approach,

which enables scalable, rapid re-use with customization. The system was modularized into a library of core components, each with its own predefined features and variants. The MicroVCS program uses next-generation tools, such as IBM Engineering Lifecycle Manager and Pure::Variants, to synthesize component and system variants from a library of proven designs and features. Through this framework, the MicroVCS platform can rapidly produce custom, scalable system designs that meet the diverse needs of our customers, for the price of off-the-shelf.

One of the key success measures for the MicroVCS program is to develop and bring the product to market quickly to meet the diverse, prospective customer needs. Agile methodology was selected to enable the quick and volatile product development. At the beginning of the program, the Agile methodology was new to the team and new to Honeywell for an integrated mechanical program. The team embraced the challenge and ambiguity, and adapted the tools and processes through a few iterations, learning what didn't work. After consultation with Agile coaches, the team pivoted to a Scaled Agile Framework, which was better suited to manage the many layers of integration and tight dependencies across teams. The team also trialed several agile planning tools, and settled on IBM Engineering Lifecycle Management, which supported Scaled Agile out-of-the-box, and which also supported advanced Product Line Engineering and re-use via the integrated requirement management tool.

Through last year, the team was also faced with the impact of the pandemic. Whether it was the loss of key team members due to attrition, the changing financial situation, or the supply chain challenges, the process and infrastructure put in place has enabled the team to be resilient and keep on marching towards product development. Additive manufacturing was utilized in place of castings for expedited delivery of some parts, such as compressor and fan housings. Engineering identified alternate electronics detail parts to help facilitate fabrication of the circuit boards. Both the 20KW and 6KW core parts were successfully built ahead of schedule. The pandemic also inhibited co-location and collaboration within a physical space, which is a core tenet of agile. The team successfully overcame this challenge by using advanced collaboration tools (IBM Engineering Lifecycle Manager, Microsoft Teams) to collaborate virtually.

ORGANIZATIONAL BEST PRACTICES AND TEAM LEADERSHIP *(*Value: 35 pts*)*

Please respond to the following prompts

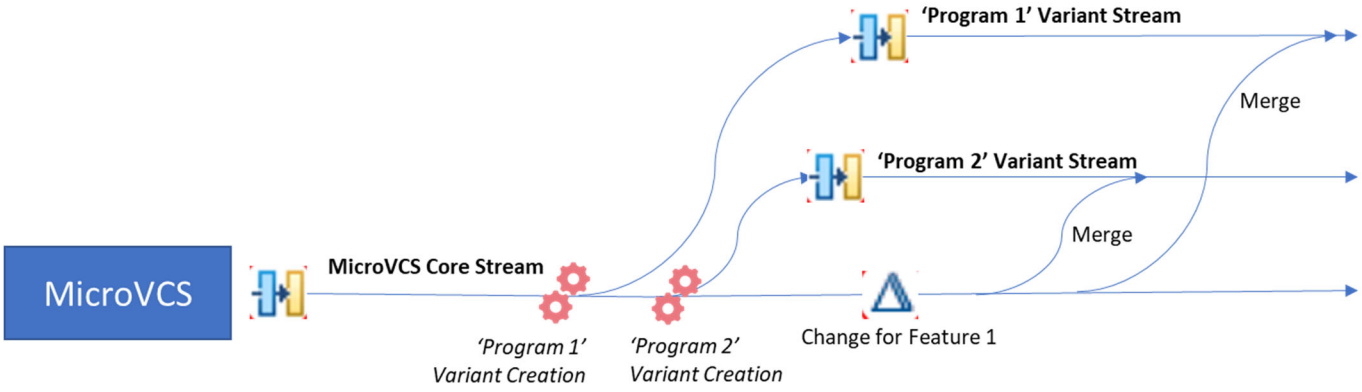
- *15 pts:* Describe the innovative tools and systems used by your team

The MicroVCS team is at the forefront of innovative and efficient aerospace systems development, leading the way within Honeywell Aerospace. The team continuously challenges the status quo and embraced novel processes and tools to minimize product weight, cost and cycle-time. The team embraced two significant and related paradigm shifts within the Aerospace development process: Product Line Engineering and Scaled Agile Framework.

A building block Product Line Engineering approach was developed to enable rapid synthesis of custom systems to meet the diverse needs of customers. Using IBM Engineering Lifecycle Manager and Pure::Variants, the MicroVCS system was modularized into a library of core components. For each component, a 'Feature Model' was developed, to capture the varying features and options. Those features were then linked to the development artifacts (requirements, code, verification), and Pure::Variants is used to automatically synthesize unique System variants. Further, the requirements management capabilities within IBM Engineering Lifecycle Manager support parallel development within Streams. This enables the team to efficiently support multiple customers in parallel, while sharing artifacts and changes across the streams, reducing duplicated effort. Through this Product Line Engineering platform,

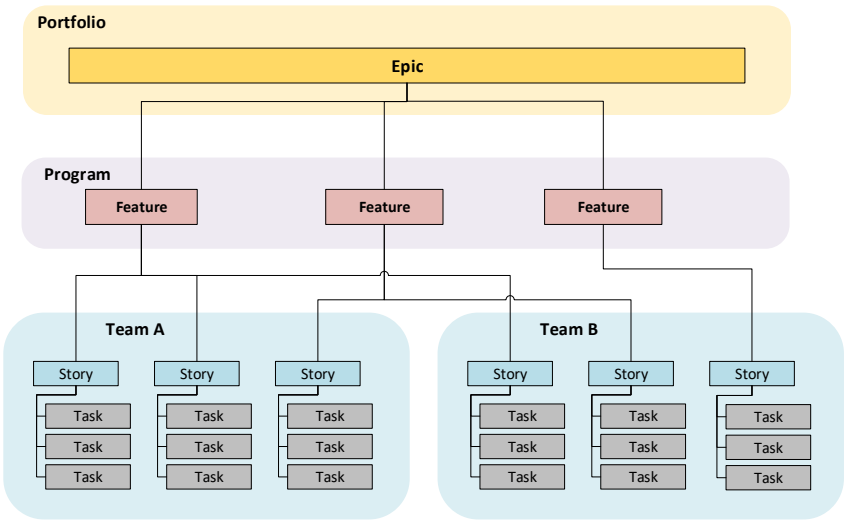
the MicroVCS team can rapidly produce and support custom, scalable system designs that meet the diverse needs of customers, for the price of off-the-shelf.

Variant Management with IBM Engineering Lifecycle Manager



The second paradigm shift within the MicroVCS team, was the deployment of Scaled Agile Framework (SAFe) to the development of a large, integrated system that includes mechanical and electronic hardware. Scaled Agile Framework enabled planning and tracking of the broader system objectives and features, with decomposition down to the stories at the individual scrum teams. This allowed scrum teams to sprint in parallel while still maintaining coordination and integration at the higher level. To manage this decomposition, the team deployed Portfolio SAFe, with Epics, Features and Stories to plan and track the work in bite-sized chunks. Epics track the significant solutions and initiatives at the portfolio level and are driven and prioritized in a backlog by the business stakeholders. The Epics are then decomposed into Features, which define a discrete functionality of the system or component and is sized to fit within a 3-month Program Increment (PI). Finally, the Features are further decomposed into Stories, which are coherent pieces of work that exist at the Scrum Team level and are sized to fit within a 3-week Sprint. See illustration below for the SAFe work item hierarchy utilized by MicroVCS.

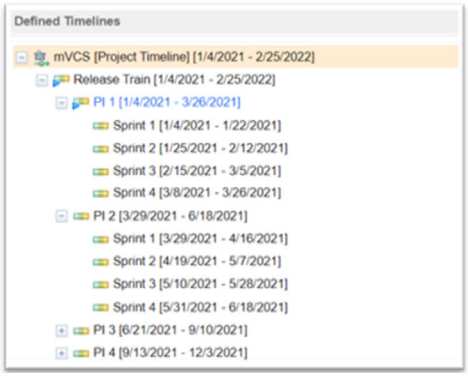
MicroVCS Portfolio SAFe Work Item Hierarchy



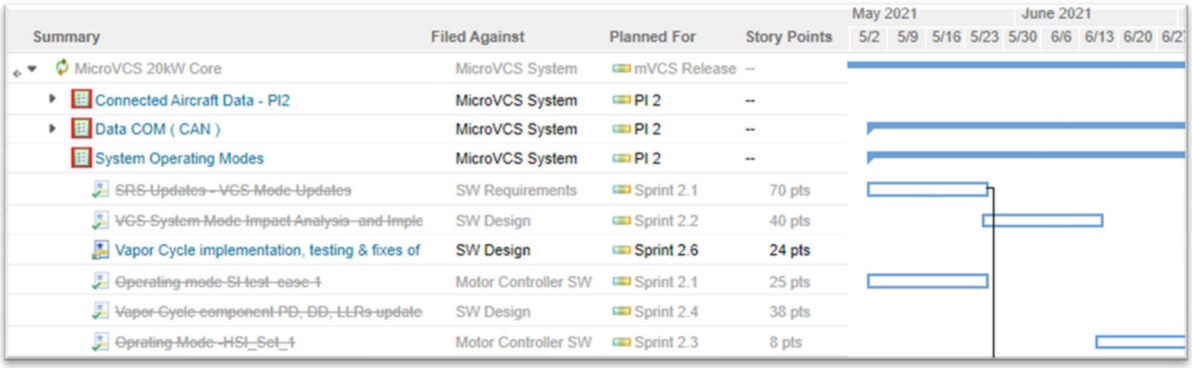
The MicroVCS SAFe Agile Release Train consists of twelve Scrum Teams executing to iterative 3-week Sprints within 3-month Program Increments. The program team performed Program Increment Planning every 3 months, where the Epics were decomposed into key system Features, which were then prioritized

and decomposed into Stories across the 12 teams. The teams then refreshed their plans and Story priorities every 3-weeks, during Sprint Planning at the start of each Sprint. Scrum meetings, Sprint reviews, and Retrospectives were all held to monitor progress and pivot as necessary. Regular opportunities for communication between the scrum team members provides timely discovery and resolution of the issues enabling smoother program execution. Periodic sprint reviews provide both an outlet for individual and team recognition, as well as planned checkpoints for experts, reviewers, and program leadership to ensure product performance and quality is being met. In addition, team members meet separately at Retrospectives to discuss what has or has not been working well, provide recognition to each other, and identify suggestions for program execution improvements to flow up the management chain.

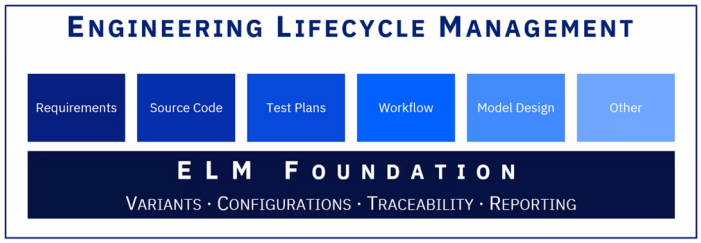
SAFe Program Timeline – Program Increments and Sprints



MicroVCS SAFe Roadmap View



To manage and track the Scaled Agile plans, MicroVCS used Engineering Workflow Manager within the IBM Engineering Lifecycle Management tool suite, which supports SAFe out-of-the-box. This tool was selected due to its native integration with the Requirements Management, Software Design and Verification tools, enabling full digital thread from the planned Feature down to the impacted requirements, code and test cases. The tool also supports robust change control, where changes can only be delivered if linked to an approved work item, with an audit trail. This is vital for Aerospace development, where certification authorities will regularly audit changes and their review artifacts.



➢ *10 pts:* Define how you developed, led and managed people

People are the most important aspect of executing a successful program. All team members are provided with extensive Agile training and support by an in-house Agile expert. Regular assessments are made to ensure any course corrections, if needed, are incorporated. Any new member is assigned a mentor to help him/her integrate with the team. People are encouraged to communicate any issues early so that there are more options for finding potential solutions. The issues could be raised in the group setting or during one on ones. To develop technical skills, several Bootcamps and Lunch and Learn sessions were held, to share technical details, design techniques and best practices.

To help lead and manage the teams, there are roles of the Scrum Master and Product Owner as part of the Agile program development. The Scrum Masters coordinate the day to day agile activities of their team to help ensure planned activities are on track. Product Owners have technical ownership of the product and help guide the team technically and prioritize the key activities for program planning. Synchronization meetings are held for coordination between Scrum Masters to tie out any dependencies or raise any impediments to the program. Product Owner meetings are also held to discuss and resolve technical issues across teams and prioritize key activities. There is also a Chief System Architect and a Program Manager who are responsible for overseeing the technical product line development and programmatic aspects of the program, respectively.

➢ *10 pts:* How did you leverage skills and technologies of your suppliers?
(12 pt. Times Roman)

The MicroVCS team implemented Early Supplier Engagement (ESE) for all critical parts of the system. Early on, the team engaged with the most skilled suppliers in different areas like casting, machining, electronics, etc. Suppliers were brought onboard on a broader MicroVCS mission of producing a best in class cooling system. Prospective down selected suppliers were involved right from the concept phase to ensure not only that the designs meet the performance and cost objectives but are also easy to manufacture. One such key example was having the Fan and Compressor housings printed using the most advanced Additive technologies rather than the traditional casting method. This enabled building the prototypes in half the time of traditional methods and testing multiple iterations with incremental improvements. Another example was integration of a supplier's heater and its controller in the Honeywell system. Working closely with the supplier and using their expertise, the team was able to collaborate and achieve the required design to cost and provide a competitive offering to our customers.