FBW09

CANEUS
FLY-BY-WIRELESS
WORKSHOP 2009

June 8-12, 2009 Montréal, Quebec

www.caneus.org/fbw09

Workshop Handbook

1.0 Preface

1.1 EXECUTIVE SUMMARY

We have restructured the 2nd CANEUS Fly-by-Wireless workshop to focus on the projects being developed in each of the major areas. Therefore, this handbook is expected to compliment the sections of the program that are particularly relevant to them. These are highlighted in the Executive Summary box below. The below information is all accessible in the workshop website.

The goal of the 2nd CANEUS Fly-by-Wireless workshop Workshops is: (a) to refine the focus projects and pertinent details, identify specific development needs, outline teaming and funding schemes, plan project oversight and execution, and establish milestones from which to gauge success of the projects, and (b) stimulate formation of project teams comprised of technology providers and application/end users and project proposals from each team that have significant mutual benefit and high potential of funding from internal of external organizations. In order to accomplish these ambitious goals, the workshop program has been structured in four parts:

I. Raison d'être for CANEUS Fly-by-Wireless Sector Consortia:

The first half-day of the Workshops will provide participants with the raison d'être of CANEUS Fly-by-Wireless Consortium and the CANEUS approach to implementing its goals. This plenary session will also address the key challenges faced in working on collaborative high-risk, high-cost projects. Issues to be addressed include intellectual property, regulatory compliance and funding.

II. Sessions Covering End-User Needs and Technology Providers Gap:

The goal of the subsequent Sessions and the presentations from world-class Experts, including those selected from the abstracts received in response to the call for papers, is to update participants on the needs and lessons learned of the aerospace (aeronautics, space and Defence) industries including the basis for the business case, as well, all aspects of fly-by-wireless technologies: the state-of-the-art in developments related to FBW, challenges, applications and to identify the technology gaps.

III. Poster sessions:

Poster sessions featuring presentations from universities, research laboratories, SME's and end-users complement the topics covered in the sessions.

IV. FBW Consortia Project Development, Implementation, and Success Criteria

These sessions are the heart of this workshop. We are endeavouring to create a program that optimizes the use of participant time to produce measurable deliverables to advance the goals and activities of each of the existing well-defined projects and identify new projects with strong business case. The topics covered in the sessions from the first and second parts of the workshop will feed into this third part of the workshop: participants will apply the knowledge acquired during the prior sessions towards formulating and implementing existing as well new projects. Finally, as a measure of the workshop success, each project team will present the findings and outcome to gauge project completion and milestone achievements, and the avenues to be pursued to overcome challenges such as intellectual property, funding, and government regulations (such as ITAR).

HANDBOOK FOR PROJECT DEVELOPMENT

We have prepared this CANEUS FBW Consortia handbook to help guide the participants through the various stages of the project preparations. Furthermore, throughout the three days of workshop activities, you will be given extra documents and notes to add to the Handbook manual in order to supply you with the tools needed to participate in all the planning processes. Please make a special effort to keep your Handbook up-to-date by adding documents and presentation notes. Doing so will enable you to maximize the benefits from this workshop. By the last workshop session, this document is expected to be complete and an accessible, take-home guide for the entire workshop.

2.0 Workshop Schedule

	Monday June 8	**Tuesday** June 9	**Wednesday** June 10
	Plenary & End User Briefings	**Technology Provider Briefings**	**Project Development, Implementation and Success Criteria**
07:30-08:30	Registration		
08:30-09:00	**Session 1** Welcome, Introduction and Workshop Overview	Keynote Address **Fu-Kuo Chang** SCL Stanford University	Keynote Address **Bob Walker** DRDC-DND
09:00-09:30		**Session 7** Sensor DAQ Micro-Miniaturization Passive Wireless Sensor Tag Less–Wire Architectures	**Session 11** Overview of Projects
09:30-10:00	Keynote Address **Mairead Lavery** (TBC) Bombardier Aerospace Montreal		
10:00-10:30	Coffee Break	Coffee Break	Coffee Break
10:30-11:30	**Session 2** Raison d'être of FBW Consortia & Projects	**Session 8** Sensor DAQ Micro-Miniaturization Passive Wireless Sensor Tag Less–Wire Architectures	**Session 12** Funding Opportunities
11:30-12:00	**Session 3** Overview of Key Issues (IP, Funding, NDA and Export Control)		
12:00-13:30	Keynote Address + Lunch **Radoslaw R. Zakrzewski** Goodrich Corporation	Keynote Address + Lunch **Radislav A. Potyrailo** GE Global Research Center NY	Keynote Address + Lunch **Sherry Noble** Export Development Corporation
	End User Briefings	**Technology Provider Briefings**	**Project Reports**
13:30-14:00	Keynote Address **Victor Giurgiutiu** Air Force Office of Scientific Research (AFOSR)	Keynote Address **Tribikram Kundu** University of Arizona	Keynote Address **Duane Cuttrell** LMCO - Skunk Works
14:00-15:00	**Session 4** Structural Health Monitoring **+ Round-table Discussion**	**Session 9** Structural Health Monitoring Instrumentation Wireless systems immunity in Electromagnetic Environment	**Session 13** Project Success Criteria **Linda Beth Schilling** and **Frank Barros** ATP-NIST, Dept. of Commerce, USA
15:00-15:30	Coffee Break	Coffee Break	Coffee Break
15:30-16:00	Keynote Address **John McGraw** FAA	Keynote Address **Minoru Taya** University of Washington	**Session 14** Project Summary
16:00-17:00	**Session 5** Passive Wireless Sensor Tag and Sensor DAQ Micro-Miniaturization **+ Round-table Discussion**	**Session 10** Structural Health Monitoring Instrumentation Wireless systems immunity in Electromagnetic Environment	**Session 15** CEO/CTO Expert Panel Discussion Chairs: **Suzanna Benoit*** and **John Legette*** Panelists: **Adarsh Deepak**, **Jacques Daoust***, **Phil Dion***, and **Rothschild***
17:00-17:30	**Session 6** Wireless systems immunity in Electromagnetic Environment (HIRF, Lightning etc) **+ Round-table Discussion**		Conclusion
17:30-19:00	Student Poster Session + Wine and Cheese	Student Poster Session + Wine and Cheese Banquet Keynote Address **Francois Caza** Bombardier Aerospace	Project Group Leadership Dinner

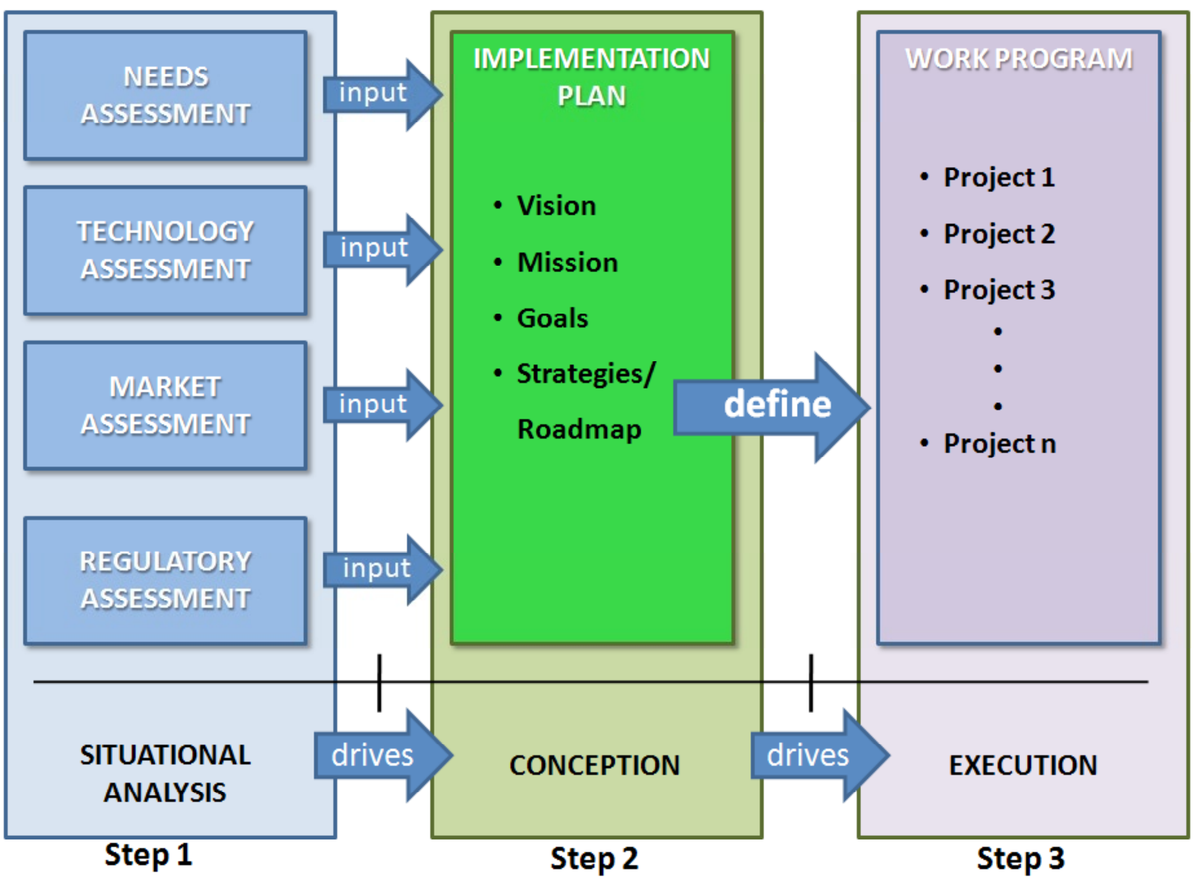
* to be confirmed

	Thursday June 11	Friday June 12
	Technical Tours	**Technical Tours**
AM	**Canadian Space Agency**	**CAE Electronics Simulator**
	Technical Tours	**Technical Tours**
PM	**Bombardier Aircraft Manufacturer**	**Air Canada**

3.0 Workshop Process

During the CANEUS 2009 Workshop at NASA's Ames Research Center in March, the planning process illustrated in **Figure 1** was used to guide the activities throughout the workshop. The FBW Sector Consortia progressed to Step 3 where the project definition activities require a more detailed oriented effort.

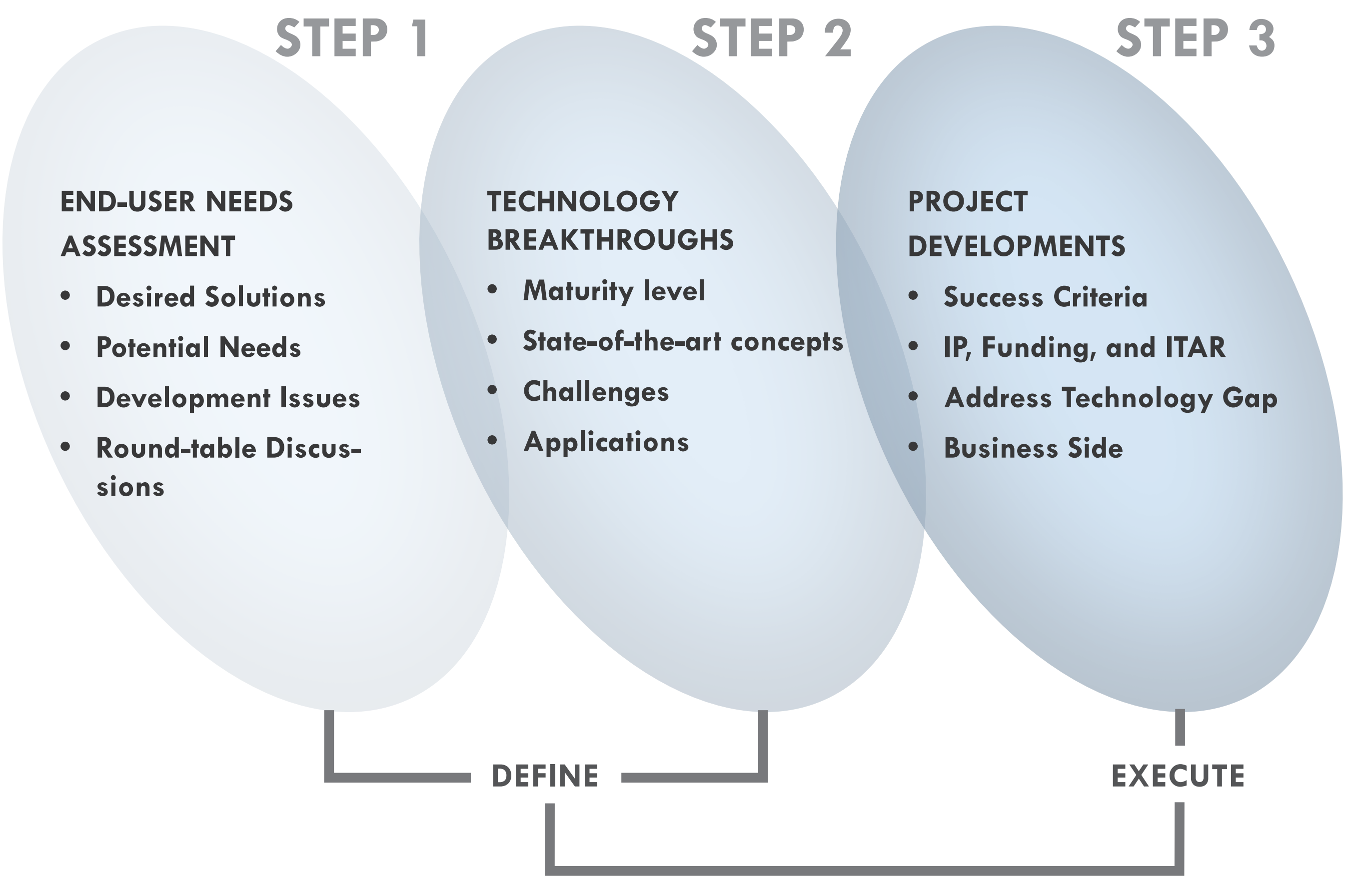
Figure 1. CANEUS 2009 Planning Process



At the FBW09 workshop in Montreal, we will be taking further steps, as illustrated in **Figure 2** to "nail down" the details by:

- reviewing the accomplishments of the last workshop (part of Monday's activities),
- further refining end-user/customer requirements (Monday's activities),
- further evaluating a targeted portfolio of wireless/less wire related technologies (Tuesday's activities),
- And, using the information from Mondays and Tuesday's efforts, and applying CANEUS' Project Concept Proposal guide lines from the template (see appendix C), we will define projects and associated teams (Wednesday's activities) that will in turn be responsible for the execution of the tasks identified by the workshop participants.

Figure 2. FBW09 Worksop Process



3.1 DAY 1: PLENARY AND END-USER BRIEFINGS

After day 1 of the workshop participants should walk away with a clear understanding of the:

- workshop process
- CANEUS vision, mission, and goals
- the raison d'être of FBW consortia
- project developments from past meetings
- relevant funding, IP, and regulatory considerations
- clear understanding of end-user and customer needs as related to:
- Structural Health Monitoring
- Passive Wireless Sensor Tag
- Sensor DAQ Micro-Miniaturization
- EMC- HIRF
- project concepts/ideas from end-user/customers that could offer potential solutions for identified needs

3.1.1 MONDAY AM (SESSIONS 1 TO 3)

Raison D'etre For The Caneus Fly-By-Wireless Consortia Projects

The plenary session outlines the mission, vision, and goals of the CANEUS Fly-by-Wireless Consortium as well as presentations from visionaries from Canada, USA, Europe, and elsewhere to minimize cables and connectors across the aerospace industry. The first half-day of the Workshops will provide participants with the raison d'être of FBW consortia and the CANEUS approach to implementing its goals. This plenary session will also address the key challenges faced in working on collaborative high-risk, high-cost projects. Issues to be addressed include ITAR, intellectual property, non-disclosure agreements, and funding.

A more detailed description of these sessions follows:

CANEUS FBW Consortium: Mission, Vision & Goals This plenary session outlines the mission, vision, and goals of CANEUS Fly-by-Wireless Consortium, as well as the innovation CANEUS framework and the methodology of CANEUS' current projects.

The raison d'être of FBW consortia and Projects: This plenary session makes a case for the "Valley of Death." This session will also cover the process for launching Sector Consortia and projects within the CANEUS innovation framework. It will also outline the approach of FBW Consortia to implement its roadmaps, covering the end-user needs and technology assessment, and success metrics.

Overview of Key Issues: This plenary session will address the key challenges faced by all Sector Consortia in working on collaborative high-risk and high-cost projects. Issues to be addressed include intellectual property, non-disclosure agreements, funding, and government regulations.

3.1.2 MONDAY PM (SESSIONS 4 TO 6)

Sessions Covering End-User's Needs Briefings: The presentations of the End-User Briefing sessions are intended to provide input to the FBW Project development sessions. We have provided speakers a template to address key issues in their respective presentation. In order to obtain maximum output from these sessions to be relevant to the projects, please provide any and all questions that you would like answered for any of the Sessions 4 to 6 to the Workshop Technical Co-Chairs.

3.2 DAY 2: TECHNOLOGY PROVIDER BRIEFINGS (SESSIONS 7-10)

The Day 2 of the workshop presentations supports the "technology assessment". After day 2 of the workshop participants should walk away with a clear understanding of the:

- current technology and project developments of relevant Fly By Wireless technology providers
- maturity level of current technology developments
- state-of-the art or bleeding-edge technology concepts

Sessions Covering Technology Provider Briefings: These Sessions will review the state-of-the-art and technology breakthroughs being made worldwide that can reduce aerospace cabling. For example, Surface Acoustic Wave (SAW) sensors are making their commercial debut in temperature and pressure applications. Low power, adaptive, and robust radio technologies and systems are being used for important wireless applications in several Space Agency programs. Some aircraft now have FAA-approved wireless devices, e.g. a breakthrough has produced a no-power sensor-tag system that can collect data from a variety of common sensors and switches at distances useable for aerospace vehicle applications.

Speakers will discuss exciting developments from their own organizations to meet the challenging requirements of next generation aircraft and spacecraft applications. Each speaker will present recent advances in his/her organization within the context of potential collaborative projects, to a proof-of-principle level of maturity, and speculate on the path and timeframe for future system-level development.

3.3 DAY 3: PROJECT DEVELOPMENT, IMPLEMENTATION AND SUCCESS CRITERIA

After day 3 of the workshop participants should walk away with a clear understanding of the:

- The goals and activities of each of the existing well-defined projects as well identify new projects with strong business case.
- Priority of government programs to fund and procure relevant FBW projects and technology developments
- Selection criteria, metrics for assessment, project duration expectations, and transition or infusion strategies for these types of aerospace funding initiatives
- Cross agency and international organization core competencies in developing new technology concepts to a proof-of-concept maturity level?
- Important considerations regarding

3.3.1 WEDNESDAY AM (SESSIONS 11-12)

Overview of Project Development

The Project Development Sessions are the heart of this event. We have endeavoured to create a program that optimizes the use of participant time to produce measurable deliverables to advance the goals and activities of each of the existing well-defined projects as well identify new projects with strong business case.
These sessions aim to refine the well-defined projects, both existing reviewed as well as new proposed: participants will outline teaming and funding schemes, plan project oversight and execution, and establish milestones from which to gauge success of the project. It is our hope that we will be able to include the participation of those who are interested in more than one area, and include the participation of a wide range of expertise.

Based on the understanding of what solutions may be desired by end-users/customers (Day 1) and the maturity of currently developing technologies (Day 2), participants will apply the knowledge acquired during the prior sessions towards formulating and implementing existing as well as new projects Teams on day three therefore work towards developing project frameworks by leveraging the involvement of consortium members including technology providers, end-users, customers, integrators, and other value chain members.

Funding Opportunities

Funding provides the life-blood for initiating, maturing and implementing new systems. This session will address the priorities of government programs in developing and funding such programs, as well as potential projects, leading to procurement actions.

3.3.2 WEDNESDAY PM (SESSIONS 13-15)

Project Reports

(a) Project Success Criteria (Sessions 13)

This session will address the selection criteria, metrics used for assessing progress, program duration, and strategies for infusing these technologies into aerospace applications. In this session, participants delve further into focused activities to include tasks, responsibilities, timelines, teaming, budget, and success evaluation metrics.

(b) Project Summary (Sessions 14)

This sessions aim to summarize the output of each of the project teams. In this session, workshop participants have the opportunity to learn about the activities and implementation plan of all proposed project teams.

CEO/CTO/Expert Panel (Session 15)

Lastly, to demonstrate the deliverables of this workshop, we have included a CEO/CTO/Expert panel session representing key experts to comment on the various projects as well offer their vision for each areas.

Workshop Conclusion

This plenary session will summarize the output of the 2nd CANEUS Fly-by-Wireless Workshop.

4.0 Fly-By-Wireless Sector Consortium

4.1 BACKGROUND

CANEUS' primary mission is to rapidly and cost-effectively bridge the mid-TRL "Valley of Death" for transitioning emerging micro-nano technologies to aerospace systems, thereby enabling next generation missions with advanced capabilities. Since the nature of these transitioning projects varies on a project-by-project basis, CANEUS has put in place an extremely "lean" and flexible core organization that relies primarily on its membership to create the collaborative virtual organizations necessary for the advocacy and ultimately the manufacture and demonstration of specific MNT-based systems for aerospace end users. CANEUS adds value by bringing together its global network of professionals with complementary skill-sets, from the low TRL researchers to the mid-TRL system developers and the high-TRL system testing, integration and reliability assurance personnel. As the premier advocacy organization for aerospace MNT system development, CANEUS has gained the trust of both private and government sponsors as a reliable, due-diligence body for vetting and "packaging" system development projects to minimize the investment risks by these sponsors.

Potential MNT system development projects are proposed, defined, and peer-reviewed by the members of CANEUS for completeness and soundness, prior to submission to potential sponsors for funding. CANEUS provides its many Conferences and Workshops as the forums for members to network and discuss these projects, and to form the teams that will be responsible for the generating the system-level end products. One of the most compelling reasons to become a member of CANEUS is to have the many opportunities to collaborate across organizations, and, if necessary, across international boundaries, on these high-risk, high-cost MNT system development projects that are beyond the resources of any single member. In essence, effective risk mitigation can be achieved under the auspices of CANEUS for the generation of new intellectual property. The primary cause for the failure of a great majority of MNT development projects in their inability to make the transition to system level, is because these projects have been largely developed in response to the inventors' vision, i.e. a "technology push" approach, and therefore stand the great risk of wrongly predicting customer demand. CANEUS overcomes this key transitioning challenge by first determining if a sustainable customer base exists for the proposed MNT system, in other words, CANEUS uses a "technology pull" approach instead to evaluate the economic viability of a specific project prior to embarking on the development effort. The system need could either be an existing customer need, or a need that is created as a result of CANEUS' advocacy activities with potential customers and end-users.

Because CANEUS activities, by necessity, have to span the continuum of technology development and commercialization, CANEUS projects could be conducted in either a small, focused collaborative group effort approach or, alternatively, as a much larger, consortium-style, development of precompetitive intellectual property that is subsequently licensed by several aerospace companies and other organizations that see the benefit in mitigating their risk for expensive, high-risk, high-payoff technology development. It is then highly probable that these precompetitive developments will spawn a host of proprietary development projects within the licensee organizations.

The Fly-by-wireless Sector Consortium is one such CANEUS group having a broad base program of developments and initiatives organized around a thematic focus of wireless/less wire MNT related technologies. It is the charter of this group to further the growth and proliferation of complete system solutions that employ wireless concepts while applying all the CANEUS concepts, methods, and resources as previously described.

4.2 INTRODUCTION

Wired data systems have huge life-cycle costs and limited reliability for aerospace vehicles. Depending upon the application, the data necessary for making many decisions can be acquired more reliably and cheaply if wireless systems are used. Ten years of operational experience in Space Shuttle and International Space Station missions have shown that low-power wireless data acquisition and communication are reliable and very useful. While RFID tags can be used for identification and tracking of objects, recent breakthroughs have resulted in devices that can provide data from sensor-tags that have no power source: their electromagnetic reflected response varies according to the sensor attached. It is clear that maturity and confidence in the safety and operations of wireless interface needs to increase if there is to be hope for widespread use. For non-critical applications, wireless interfaces are already showing to be a practical solution.

4.2.1 FBW CONSORTIUM PROFILE

A number of leaders and champions have been involved with the FBW Consortium over the past year and are currently supporting the project definition phase of the FBW work program. Following are the names involved in this workshop's activities.

FBW Topic / Consortium Leaders:

Co-Leader of Structural Vehicle Health Monitoring (SHM) Initiative:

- Robab Safa-Bakhsh, Boeing, USA
- Jim Castellano, Industry Canada

Co-Leader of Sensor DAQ Miniaturization Initiative:

- David Russel, NRC-IAR

Leader of Passive Sensor Tag Initiative:

- Ali Abedi, University of Maine

Leader of Less-Wire / Architectures Initiative:

- Brian McCabe, Sikorsky Aircraft

Wireless systems immunity in Electromagnetic Environment (HIRF, Lightning etc)

- Fidele Moupfouma, Bombardier Aerospace

4.2.2 ACTIVITY UPDATE

PAST ACTIVITIES

A. CANEUS/NASA Fly-By-Wireless Workshop for Aerospace Applications
March 27-28, 2007

On March 27-28 2007, NASA and CANEUS teamed together to hold the first "Fly-by-Wireless" Workshop (www.caneus.org/fbw07) in conjunction with RFID World 2007 Conference and the IEEE International Conference on RFID 2007. The overall goal of this initiative included:

- Establish an international forum through the CANEUS Organization to exchange public and published information on applications and technology alternatives to wires, which precipitate cooperation and partnerships between industry/government customers, system innovators and technology developers.
- Promote understanding of the capability, maturity and challenges of alternatives to wired infrastructures/ enabling technologies in order to facilitate timely regulatory and programmatic changes, vehicle architecture accommodations and prioritization of technology development.
- Enable key partnerships between End Users and technology providers on an individual and working group level.
- Formulate Working Groups from participants with common interests to identify and clarify their key common interests and formulate forward planning and potential projects. Life-cycle return on investment, Safety, Security and Mission Success are other primary drivers for working together. Leadership, purpose, products and membership are key initial objectives.
- Identify and enable proposed CANEUS FBW Projects which CANEUS membership dues are used to prepare and coordinate. These projects are then funded by a project unique routes and methods by both participating CANEUS and outside organizations.

Workshop Objectives

1. Communicate the CANEUS FBW Vision and Project Partnering
2. Develop cooperating Application/End User and Technology Provider Groups that intend to further the FBW Vision
3. Provide communication of results and additional opportunities for further development of cooperative work and partnerships

Key speakers introduced the FBW Vision to participants of the workshop, and highlighted the advantages of reducing wired interconnects. The NASA Wireless and RFID Working Group for space vehicle were strengthened. It was found that many areas of stand-alone wireless, passive sensor-tags and integrated architectures were further along than anticipated. Participants discussed potential partnering to further the FBW Vision, and partnerships that are developing to advance passive sensing technologies promise to be fruitful if they keep momentum.

Topics addressed at this Workshop included:

- Next Generation Micro-Wireless Instrumentation
- Active/Passive RFID sensing & RF Sensor-Tags
- Wireless On-board Commercial Aircraft
- Wireless Avionics Plug-n-Play Spacecraft
- Wireless for Launch Vehicles
- Wireless for Small Space Vehicles
- Wireless Engine Controls and Instrumentation
- Vehicle Architecture Provisions/Design Sys Eng
- Wireless Flight Control/control augmentation
- RF Interference Countermeasures
- Wireless Aircraft Flight Test Beds
- Wireless Ground and Flight Test Systems
- "Fly-by-Wireless" Strategic Planning
- Wireless & Less Wire TRL Assessment
- Life-cycle Cost-benefits/Lessons Learned
- Commonality with other industries
- Wireless/Connectorless Avionics Power
- Nano-tech Implications/applications
- Wireless IVHM/Prog Health Monitoring
- Wireless Standards/Interoperability
- Vertical Take-off Vehicles
- Unmanned Aerial & Surface Vehicles
- Large Area Composite Health Monitor
- FPGA/ASIC Enabling Technologies
- Wireless Habitats/Habitable Vehicle

As a result of this CANEUS/NASA led initiative, many U.S. and international organizations, those participated in the 2007 workshop, have taken steps to continue development of their wireless programs and some teaming has resulted. Many have committed to participation in future Fly-by-Wireless (FBW) working groups, and projects, including EADS, ESA, NASA IPP, and Aviation Safety Program. Meanwhile, many needs have been recently identified in the NASA Constellation Program technology assessments.

B. Fly-By-Wireless Sector Consortium Sessions at the CANEUS 2009 Workshop, NASA Ames March 1-6, 2009

The goal of the CANEUS 2009 Workshops was to significantly advance each of the CANEUS Sector Consortia by creating their roadmaps and articulating well-defined projects for the aerospace industry.

The workshop identified a set of project "blueprints", for developing the most promising concepts to system-level prototypes. One of the focus projects that were defined at the NASA Ames Workshop deals with wireless implementation for structural health monitoring of the main fuselage. Such focused project, with well defined scope for a complete system solution, is supported by all stake holders including the customers and end users, and also entails a portfolio of technology requirements. It will further apply aspects of previously defined technology roadmaps from international agencies.

CURRENT ACTIVITIES

Therefore, the 2nd Fly-by-Wireless workshop aims:

a. to refine the focus projects and pertinent details, identify specific development needs, outline teaming and funding schemes, plan project oversight and execution, and establish milestones from which to gauge success of the projects, and

b. stimulate formation of project teams comprised of technology providers and application/end users and project proposals from each team that have significant mutual benefit and high potential of funding from internal or external organizations.

By focusing on an application that is comprised of a complete system solution with a well defined scope and that is supported by all the stake holders i.e. customer, end user, systems integrator and technology provider, participants have the opportunity to build on the past technology planning and development efforts of the Aerospace community. In this way, the activities of the workshop will build on the current technology roadmaps (such as DPHM Canada and from international agencies) and the existing portfolio of technology developments, thus allowing the participants to concentrate their efforts on the technology gaps that need to be filled in order to realize a commercially viable system solution.

4.3 IMPLEMENTATION PLAN/ROADMAP

4.3.1 MISSION

The CANEUS Fly-by-Wireless Sector Consortium is chartered to provide a platform for cooperation and partnerships between industry/government customers, system integrators, and technology developers, while exchanging public and published information on the state-of-the-art wireless alternatives and new innovations. Ultimately, the Consortium's efforts will contribute to minimizing cables and connectors across the aerospace industry by providing reliable, lower cost, and higher performance alternatives for a vehicle's or program's life cycle.

4.3.2 VISION

Aerospace vehicle programs have always relied on the cables and connectors to provide power, grounding, data and time synchronization throughout a vehicle's life-cycle. Even with numerous improvements, wiring and connector problems and sensors continue to be key failure points, causing many hours of troubleshooting and replacement. Costly flight delays have been precipitated by the need to troubleshoot cables/connections and add or repair a sensor. Even with the weight penalties, wiring continues to be too expensive to remove once it is installed. Miles of test instrumentation and low flight sensor wires still plague the Aerospace industry. New technology options for data connectivity, processing and micro/nano manufacturing are making it possible to retrofit existing vehicles like the Space Shuttle. New vehicles can now develop architectures that provide for and take advantage of alternate connectivity to wires.

This project motivates the aerospace industry and technology providers to establish:

1. A new emphasis for system engineering approaches to reduce cables and connectors
2. Provisions for modularity and accessibility in the vehicle architecture
3. A set of technologies that support alternatives to wired connectivity

4.3.3 OBJECTIVES

Establish an international forum through the CANEUS Organization to provide a transition path for state-of-the-art wireless technologies at lower maturity levels by:

- Promote understanding of the maturity and capability of alternatives to wired infrastructure, such as no-power instrumentation, standalone wireless data acquisition and processing systems, and wireless control redundancy improvements, in order to facilitate timely vehicle architecture accommodations and prioritize technology development;
- Identify solution paths for key challenges such as FAA regulations, certification requirements, RF interference, structural design and access and spectrum management;
- Quantify the life cycle return on investment or mission need for various applications and opportunities to establish which investments and partnerships are most likely to succeed;
- Identify and enable key partnerships toward implementing "Fly-by-Wireless" (FBW) in Aerospace vehicles where the market shows the highest payback; develop project plans for technology maturation, and put in place the architecture and infrastructure that supports incremental implementation of anticipated technological advancements;

- Provide advocacy for its members and foster the advancement and increased use of MEMS and Nano Technology toward the expansion of the FBW market;

- Be the world's catalyst for the FBW industry to bring breakthrough (disruptive) technologies to the Aerospace and space sectors by ensuring aerospace qualification, reliability, lower cost and added value;

- By setting a global direction, create opportunities for the flexible collaboration and conduct of strategic research and development (R&D) so as to yield a significant return on investment (ROI) to the FBW industry partners.

4.3.4 STRATEGY

At the CANEUS 2009 Workshops at NASA-Ames, March 1-6, 2009, the FBW sector leaders held ad hoc voting on all previously proposed and newly (during the sector meetings) proposed FBW projects to lead the working body to a forced-consensus on additional activities to be funded. Each potential FBW Project was scored and weighted-by-agreement by the participants. From these, a detailed plan and roadmap is constructed by the CANEUS FBW Sector participants, led by the Consortium Director, over the following calendar quarter.

Templates for Roadmap and Timeline Development during the Workshop
Roadmaps and Timelines are to be developed for both short-term and long-term objectives.

Template: Overall Long-Term Roadmap for Composite FBW Initiatives Implementation:

Fly-by-Wireless Project "N"	t_0	t_0 + 1 yr	t_0 + 2 yr	t_0 + 3 yr	t_0 + 4 yr
End-Users Initiative Implementation Plan					
Technology Developers Initiative Implementation Plan					
Standards & Guidelines Initiative Implementation Plan					
Other (TBD) Implementation Plan					
Other(TBD) Implementation Plan					

Template: Overall Short-Term Roadmap for Composite FBW Initiatives Implementation:

FBW Activity	t_0	t_0 + 4 mo	t_0 + 6 mo	t_0 + 8 mo	t_0 + 12 mo
1					
2-1					
2-2					
2-3					
2-4					

Deliverables:

1. Available pieces of information and gaps
2. Action plan to fill the gaps (with budget)

After one year, the action plans from Consortium Users and Developers may be compared and CANEUS Scientific Committee may choose and decide on further actions. After one year, one may assess whether steps have been made forward.

Template: Short-Term Roadmap for EACH FBW Initiative Implementation:

Fly-by-Wireless Project "N"	t_0	t_0 + 4 mo	t_0 + 6 mo	t_0 + 8 mo	t_0 + 12 mo
End-Users Initiative Implementation Plan					
Technology Developers Initiative Implementation Plan					
Standards & Guidelines Initiative Implementation Plan					
Other (TBD) Implementation Plan					
Other(TBD) Implementation Plan					

OVERVIEW

The CANEUS Fly-by-Wireless Sector Consortium is chartered to precipitate cooperation and partnerships between industry/government customers, system integrators, and technology developers, while exchanging public and published information on wireless alternatives and new innovations, such as no-power sensor-tag systems. Ultimately, the Consortium's efforts will contribute to minimizing cables and connectors across the aerospace industry by providing reliable, lower cost, and higher performance alternatives for a vehicle's or program's life cycle.

"FLY-BY-WIRELESS" CONCEPT

CANEUS together with NASA has championed the concept of reduced wired connectivity for aerospace vehicle architectures and systems by development and implementation of reliable less-wire and wireless alternatives as they mature. It involves new approaches for management of these changes, vehicle and system engineering, maturing alternative technologies to wired connectivity.

RATIONALE

Limitations imposed by wired connectivity and the life-cycle costs, are common to aerospace vehicle programs world-wide. With the availability of "less wire" and wireless alternatives, we can begin to address some of these issues: the cost of basic installation, wiring and connector reliability and performance, cost due to a lack of flexibility and modularity, cost of data not obtained, and difficulty in increasing system redundancy. Even with numerous improvements, wiring and connector problems continue to be key failure points, causing many hours of troubleshooting and replacement. Costly flight delays have been precipitated by the need to troubleshoot cables and connections. Wiring continues to be too expensive to remove once it is installed, even with the weight penalties. Miles of test instrumentation and flight sensor wires still plague the aerospace industry. New technology options for data connectivity, processing, and micro- and nano- manufacturing are making it possible to retrofit existing vehicles, as evidenced with the Space Shuttle. New vehicles can now develop architectures that provide for, and take advantage of, alternatives to wired connectivity more efficiently than for Shuttle. The CANEUS Fly-by-Wireless Consortium projects assures that aerospace agencies and companies, fully leverage external advancements in identified key areas, and focus its resources on remaining challenges, which may be organization-unique.

TECHNICAL CHALLENGE

There are many limitations and impacts of wired connectivity on aerospace vehicles and the aerospace industry. The technical challenge is to reduce the wired connectivity for aerospace vehicle architectures and systems by providing reliable "less wire" and wireless technology alternatives as well as vehicle provisions to take advantage of them as the technology maturity and availability increases. The approach can be addressed by looking at three levels:

A. System Engineering and Integration to reduce cables and connectors

- Capture the true program effects of cabling in launch & manned vehicles
- Requirements that enable and integrate alternatives to wires
- Metrics that best monitor progress or lack of progress toward goals. (e.g. # cables, Length, # of connectors, # penetrations, overall weight/ connectivity)
- Limit number of bits that need to flow (reduce data traffic) by design
- Design Approach that baselines cables only when proven alternatives are shown not practical - use weight and center of gravity until cabling can be proven needed.
- Fault tolerance analyses provide rationale for wireless alternatives when appropriate.

B. Provisions for modularity and accessibility in the vehicle architecture

- Vehicle Zones need to be assessed for accessibility – driven by structural inspections, system assembly, failure modes and inspections, and system and environment monitoring and potential component trouble-shooting, remove & repair
- Vehicle Zones need to be assessed for resource plug in points to access basic vehicle power, two-way data/commands, grounding and time (not all zones get it).
- System Designs that allow for use of additional sensors and redundant communications paths for use in non-critical and augmenting functions (like an auto-pilot).
- Centralized & De-centralized approaches are available for measurement & control; Be able to derive the answers as close to the sensor as practical
- Entire life-cycle needs to be considered in addition to schedule, performance, weight.

C. Development of Alternatives to wired connectivity for the system designers & operators

a. Multi-drop Bus-based systems
b. Wireless No-power sensors/sensor-tags
c. Standalone robust wireless data acquisition
d. Standard interfaces & operability
e. Wireless controls – back-up or low criticality
f. Robust high-speed wireless avionics comm.
g. Wireless tools and equipment for crews payloads
h. Data on power lines
i. No connectors for avionics power
j. Robust programmable radios
k. Light weight coatings, shielding, connectors
l. RFID for ID, position, data, & sensing
m. High speed data on white light LEDS
n. Onboard frequency spectrum required
o. Wireless services for customers

LIFE-CYCLE COST-BENEFIT

Some of the parameters to look at will be

I. **Failures of Wires and Connectors:** A large percentage of trouble-shooting results from problems related to wires and connector failures. Provisions in avionics and vehicle design are essential to control and mitigate the hazards from these potential failures. Avionics systems must build in high reliability into electronics and conduct extensive analysis and test to increase the reliability cables, connectors, and sensors.

II. **Direct Costs:** Measurement justification, design and implementation, structural provisions, inspection, test, retest after avionics r&r, logistics, vendor availability, etc. Every system team participates in the process of justifying sensors/data from the early design cycle through to the end of vehicle life.

III. **The Price of Copper:** Four times the price it was in 2002, the price of copper has to be a factor in economics of providing connectivity.

IV. **Cost of Change/Inflexibility:** Changes are typically needed as the vehicle life-cycle progresses and missions are flown and experience is gained and problems are found. Instrumentation needs to be easily adaptable to these changing conditions.

V. **Cost of late Changes:** Cost of change grows enormously as each flight grows closer, as the infrastructure grows more entrenched, as more flights are "lined-up" the cost of delays no matter what the reason grows exponentially and trouble-shooting and re-wiring cabling issues can sometimes be the cause.

VI. **Cost of Data not obtained:** Performance, analyses, safety, operations restrictions, environments and model validations, system modifications and upgrades, troubleshooting, end of life certification and extension. The data acquisition systems have been typically centralized, limiting the number of channels and unique specifications available.

VII. **Cost of Vehicle Resources:** Resources needed to accommodate the connectivity or lack of measurements come in the form of weight, volume, power, etc. Cable length and number of connectors are often not used as important metrics in assessing changes that involve new measurements or other changes. It is the job of the instrumentation team to minimize these, but haven't had the luxury of alternatives to cables up till now.

VIII. **Cost of Flexibility of Vehicle Design:** Cabling connectivity has little design flexibility and upgrades for avionics, sensors and cables are difficult. Robustness of wireless interconnects can match the need for functionality and level of criticality or hazard control appropriate for each application, including the provisions in structural design and use of materials. The result is that the requested data is often not available when it is needed because of cost, and the lead time required for nominal or late requests.

IX. **Performance:** Weight is not just the weight of the cables, it is insulation, bundles, brackets, connectors, bulkheads, cable trays, structural attachment and reinforcement, and of course the resulting impact on payloads/operations. Upgrading various systems is more difficult with cabled systems. EMI/EMC and channel noise is always a consideration when running wires.

X. **Physical Restrictions:** Design and operations can make it impossible or impractical to use cabled connectivity for monitoring. Structural barriers can limit personnel access and connections to vehicle resources(like power and data). In-situ assembly and deployment of un-powered vehicle components can preclude wired connectivity. Other physical circumstances that drive the need for wireless communications for vehicles include operations performed by crew members, robots and robotic mechanisms, proximity monitoring at launch, landing or mission operations.

XI. **New Composite Structures:** Fairly new to commercial aircraft and spacecraft, composite structures demand a degree of conservatism in their use, driving a desire for more test and health monitoring sensors.

XII. **The Negative Perception of Wireless Reliability and Safety:** Wireless systems have been perceived to be unreliable for data acquisition and control. Yet for 10 years, NASA has been flying low power radio data acquisition systems – useful for low criticality purposes with increasing functionality and dependence. Low power wireless operations near pyrotechnics and in explosive atmospheres has been certified on Shuttle.

XIII. **Limited provisions for accommodating wireless connectivity:** In current vehicle designs, lack of access and utilities in many zones make the use of new wireless options less attractive, and sometimes impossible.

XIV. **Onboard wireless demands have been perceived to be too high for the frequency space available:** Distributed processing options that are now available allow for distributed data acquisition systems to store raw data and produce answers to be transmitted, with raw data segments transmitted on request.

XV. **Wireless Instrumentation Systems have had to provide cables to the sensors:** Where the sensor can be included with the small wireless package, gather and transmit data, this is not a problem, but many sensors must be mounted or suspended away from the data acquisition card. This wire from sensor to data acquisition box diminishes some of the advantages of using wireless systems.

CHALLENGES FOR WIRELESS AND "LESS WIRE" TECHNOLOGIES

There are many issues associated with onboard wireless that must be addressed in order to enable its widespread acceptance for critical applications. Depending on the application, some of these issues might include dynamic and possibly unlimited boundary conditions that alter the propagation channel, greater susceptibility to electromagnetic interference and jamming signals, synchronization issues, less security, power limitations, troubleshooting, and, typically, a requirement for increased propagation space.

Although the performance bounds and limitations of wires are very well known, the ultimate limitations of wireless and "less wire" technologies, in the context of reducing wire weight in critical onboard applications, have not been established. Because of the potential of wireless and "less-wire" technologies to reduce vehicle wire weight, it is important to fully understand these limitations. This workshop fosters the widespread collaboration and cross-pollination of ideas that are necessary to reach that understanding. It also assembles end-users, who are provided the opportunity to disseminate critical requirements and needs, and providers, who are afforded an audience of potential clients as well as a vision of an emerging market.

PROJECTS

Several projects are identified and proposed for investigating technologies with the potential to reduce vehicle wire weight and improve vehicle reliability and performance. The project(s) involves several organizations, with a goal to minimize internal investment required to mature new architectures and enabling technologies. By leveraging external partnerships, each partner can focus funding on unique aspects of these technologies. The key focus is to take advantage of on-going working groups and projects as well as identify new proposals. A CANEUS project will be initiated to demonstrate the value of partnerships in reducing the cost of applying fly-by-wireless technologies and architecture principles. State of the art wireless data acquisition systems and wireless sensors will be applied to an aircraft and spacecraft hardware monitoring configuration in a way that demonstrates the principles and added value of this approach. A joint life-cycle cost study, will be generated to provide better data for future investigations and applications. The intention is to develop and share vision where appropriate and facilitate progress through cooperation and partnerships across CANEUS regions.

4.4 PARTICIPANTS

5.0 Projects

5.1 SCOPE

The CANEUS Fly-by-Wireless (FBW) Consortium builds on: (a) the vision, mission and goal defined at the 1st CANEUS/NASA Fly-by-Wireless Workshop held in March 2007 and (b)focus projects that were proposed and formulated at the Fly-By-Wireless Sector Consortium sessions held at CANEUS 2009 workshop at NASA Ames on March 1-6, 2009. The goal of the CANEUS 2009 Workshops was to significantly advance each of the CANEUS Sector Consortia by creating their roadmaps and articulating well-defined projects for the aerospace industry.

One of the focus projects that were defined at the NASA Ames Workshop deals with wireless implementation for structural health monitoring of the main fuselage.

Therefore, the CANEUS Fly-by-Wireless Consortium aims: (a) to refine the focus projects and pertinent details, identify specific development needs, outline teaming and funding schemes, plan project oversight and execution, and establish milestones from which to gauge success of the projects, and (b) stimulate formation of project teams comprised of technology providers and application/end users and project proposals from each team that have significant mutual benefit and high potential of funding from internal or external organizations.

CANEUS' innovation and commercialization model employs a distinctive concept for the project definition and implementation process. A number of different types of projects are recognized, and the definition and implementation process emphasizes the realization and planning for critical success factors that ensure the projects make it through the continuum from concept to technology insertion to market deployment. The CANEUS innovation and commercialization model also in based on an "open innovation" concept and therefore emphasizes intra-project coordination which is also reflected in the definition and implementation process. Following is an explanation of the process and each of the projects mentioned in section 5.5 must be advanced through the procedures.

5.2 PROJECT CLASSIFICATIONS

In the CANEUS innovation Model, a number of distinctive types of Project are recognized, each having a unique set of characteristics and therefore, each is managed in a slightly different manner. As a result, CANEUS Projects are classified in one of three ways:

- **Type 1 - Development** (product, process or service);

- Or -

- **Type 2 - Initiative** (such as establishing standards for technology acceptance, performing a market study or creating a position paper, etc. – anything that promotes the accretion of MNT);

- Or -

- **Type 3 - Sector Consortium** (a thematic program of developments and initiatives with a technology, application, or stake holder focus).

5.2.1 TYPE 1 - DEVELOPMENT PROJECT

A **development** project can be product related, process related or service related and in general, provides a total solution to an identified need that someone is willing to pay for and someone is willing to provide. Development type projects are by far the most popular for the CANEUS constituency.

5.2.2 TYPE 2 – INITIATIVE PROJECT

An **initiative** is typically established to either promote the growth of MNT in the Aerospace community or to overcome any of the challenges that potentially impede the acceptance of these far reaching concepts. Examples include the establishment of standards to promote technology acceptance, performing a market study or creating a position paper, or establishing a data base that includes a description of all the member's facilities, capabilities and in house expertise, etc.

5.2.3 TYPE 3 - SECTOR CONSORTIUM PROJECT

A **Sector Consortium** project is a broad program of developments and initiatives that centers on a technology, application, or stakeholder theme. The FBW Sector Consortium is an example of such an entity. Sector Consortiums also prosecute their own set of projects. And the programs of each Sector Consortium are extensive enough that they are required to establish an Implementation Plan and Roadmap that is continually updated. CANEUS is currently managing 5 Sector Consortiums:

- Materials Sector Consortium (a technology theme)
- Devices Sector Consortium (a technology theme)
- Small Satellite Sector Consortium (an application theme)
- Fly By Wireless Sector Consortium (an application theme)
- Reliability Sector Consortium (a technology theme)

Whenever defining a project, team members should keep the other sector consortia in mind since they represent potential opportunities to leverage a project's benefits and resources which will vastly improve the business case for the project.

5.3 PROJECT DEFINITION AND IMPLEMENTATION PROCESS

CANEUS uses a 2 step approach to define projects. The process is divided into a **Project Concept Proposal** step and a **Detailed Project Plan** step. The first step of the process results in a Quad chart and an associated supporting document (see appendix C and D) that represents a high level description of the project. The first step is intentionally made simple so that an inordinate amount of resource is not expended by your organization on a project concept proposal that may not appeal to a broad base of members. The Quad chart along with associated documents is submitted to the CANEUS Project Review Committee for their approval. Once the go ahead is given, and all the team members become (or may already be) a CANEUS member (thereby establishing an umbrella of protection, i.e. IP terms, NDA, regulatory compliance all established) the project team may progress to step 2 – the **Detail Project Plan** phase. The completion of the Quad chart and supporting documents is the phase of the definition and implementation process we are striving to achieve at this workshop.

A **Detailed Project Plan** is an extension of the **Project Concept** proposal but with much greater detail that includes proprietary content especially as relates to unique technology development, work breakdown, costs, specific IP terms and the business model. The step also includes the preparation and execution of a teaming agreement that is specific to the project and legally binds the team members to the project plan.

Once a Quad chart is submitted, the CANEUS organization (including its members) becomes actively involved in "shepherding" the project through its various life-cycle phases with the close involvement of both the potential financial sponsors and the end-customers. CANEUS strongly believes that such an intimate collaboration between all the stake-holders is necessary right from the inception of the project in order to ensure the ultimate success in transitioning MNT concepts to the aerospace system level.

5.3.1 STEP 1 - PROJECT CONCEPT PROPOSAL

To initiate a project, one must first start with a Quad chart (see appendix C: Project Concept Proposal Template: Type 1 – Development Project, and appendix D: Project Concept Proposal Template: Type 2 – Initiative Project) and fill in the fields of requested information. A narrative document that includes a list of critical factors is also attached to the Quad chart to provide additional background. A **Project Concept** proposal describes the innovative technology or initiative, state of the art, current maturity level of the technology, and projected maturity level at the conclusion of the project, commercial viability, leading organizations in the business space, key technology developers, potentially interested parties, and any challenges or outstanding issues (such as government regulations) involved.

Once a Quad Chart is created the proposer can use the document as a "sales brochure" to garner support and refine the concept. This leads to the creation of a mature **Project Concept Proposal** which provides a quick overview of a particular opportunity to deploy MNT into the Aerospace community or to promote the growth of MNT. The proposal is considered a public domain document and should not contain proprietary information.

CANEUS will work with the proposer from the Aerospace community or Membership to refine and then circulate the **Project Concept Proposal** among the members of CANEUS and eventually to the Project Review Committee (made up of the Project Support Group Leaders – see section 5.0). The **Project Concept Proposal** from a Sector Consortium must also describe how the project addresses the critical factors outlined in the Implementation Plan and Roadmap.

5.3.2 STEP 2 - DETAILED PROJECT PLAN

In addition to the information contained in the **Project Concept Proposal**, and if the concept is a Type 1 Development project, the **Detailed Project Plan** includes a:

- detailed description of the support needed from the other Project Support Groups (see section 5.0) including a plan for each of the critical success factors;
- detailed work breakdown structure (WBS) with tasks, team responsibilities, associated costs and time line clearly stated;
- detailed project management plan
- detailed budget for the total project;
- detailed business case;
- IP agreement among the Team members;
- Teaming Agreement that legally binds all the CANEUS Team members and the CANEUS organization to the terms of the **Detailed Project Plan**

Project Member's internal costing information will be kept confidential from the other team members and CANEUS Membership. A template for the Detailed Project Plan along with a Teaming Agreement template will be posted on the CANEUS website when it becomes available (soon).

5.4 CRITICAL SUCCESS FACTORS

In the CANEUS Innovation Model, it is recognized that Projects are more successful and effective at mitigating risk and cost when they contain or address certain critical success factor. CANEUS Projects are high risk – high cost and typically of a larger scope and thus tend to have a greater number of challenges to address throughout the continuum of the development and commercialization process. Most of the Aerospace community measures this process using a system of "technology readiness levels" (TRLs), of which there are 9. The middle TRLs (typically TRL 3 to TRL 5) are sometimes referred to as the "valley of death" and have proven to represent the greatest challenge of all (see Appendix E). To mitigate the risk and cost associated with this process and to ensure all the TRLs are handled expeditiously, the CANEUS Innovation and commercialization model uses a "recipe for success" that lays out the critical constituents that should be included in every CANEUS Type 1 – Development Project.

5.4.1 DEVELOPMENT PROJECT - CRITICAL FACTORS

A CANEUS Type 1 - *development* project "provides a total solution to an identified need that someone is willing to pay for and someone is willing to provide". The implication is that: a portfolio of technologies is involved; an application with its attendant requirements has been identified; and a supply chain of partners is poised to develop, manufacture, support and purchase the solution. Therefore, from the standpoint of the CANEUS Innovation and Commercialization Model, the ideal development project involves a collaboration of CANEUS Members that;

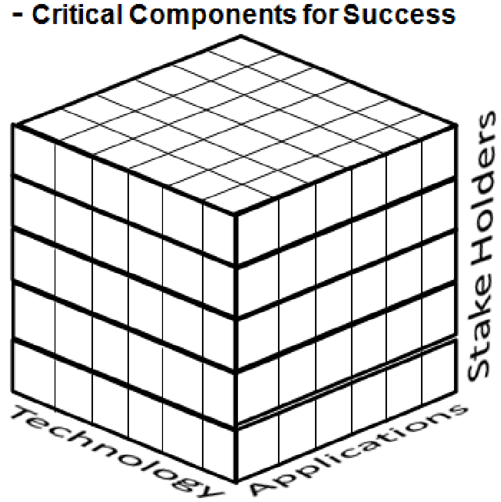
- provides a solution for a number of aerospace **applications**;
- involves a portfolio of **technology** development and;
- is developed by a project team made up of **stake holders** that function as supply chain partners - the project team must have the resources to not only create but also, to deploy and support the resulting MNT product, process or service in the market place.

Development projects that address these critical components have the highest probability of success and provide the best opportunity to leverage the resources of the CANEUS membership.

Figure 5.1 provides a pictorial visualization of this concept through the application of a 3 axis cube. By applying the categories from the tables to the axis of the cube, and shading in the boxes that are addressed by any given CANEUS *development* project, an indication of potential success can be attained. The greater the number of technologies, applications, and stake holders involved in a project, the denser the cube becomes and the higher the probability of success. The project team should always have this frame work in mind during the project definition stage so that every effort is made to fill in as many boxes in the cube as possible thereby setting the stage for success.

CANEUS Development Project Cube

- Critical Components for Success



Technologies

- Materials
- Electronics
- Controls
- Sensors
- Power
- Optics
- Fluid
- Processes
- Quality Systems

Stake Holders

- End Users
- Systems Integrators
- Component Suppliers
- Agencies
- Academia
- Process Suppliers

Applications

Aircraft

- **Fixed Wing**
  - Air Frame
  - Fight controls
  - Avionics
  - Propulsion
  - Accessories
- **Rotary Wing**
  - Air Frame
  - Fight controls
  - Avionics
  - Propulsion
  - Accessories

Space

- **Payload**
  - Satellites
  - Manned Vehicles
  - Cargo
- **Launch Vehicle**
- **Ground Support**

Figure 5.1. Crucial Relationship Between Critical Success Factors of Type 1 – Development Project

In addition to the critical relationship between the stake holders, application, and technology components, a number of other critical success factors need to be addressed in order to mitigate the risk and cost of project. Following is a complete list of the critical success factors:

Outreach	What other organization have efforts in the same subject area (both in and external to the Aerospace community)? What have other organizations accomplished in the related developments? What organizations can you partner with and what licensing opportunities exist?
Technology	What other complementary technologies are involved or are needed – system solutions come from a portfolio of technologies? What other CANEUS Sector Consortia can benefit from the developments associated with your organization' project? What other complementary technologies or developments that are needed by your project are addressed by the other CANEUS Sector Consortia?
Applications	What other applications can take advantage of the benefit from the project – the more, the better and the stronger the business case? Identify the Aerospace applications that may be able to benefit from your development project. (Refer to the list in the Workshop call for papers.) Identify the other applications outside of the Aerospace market that may be able to benefit from your technology development.
Stake Holders	What groups in the supply chain need to be involved? Identify the customer/end user that is involved or is a candidate to be involved with your development project. Identify the systems integrator responsible for the complete system that incorporates your technology into the final product/process. Identify the other businesses, agencies, or institutions that are or could be part of your project. List the organization and their intended roles and responsibilities.
Business Development	What is the strongest business case that can be made, what project management best practices are required, what regulatory requirements impact the project? What role can CANEUS play in mitigating the risk and improving the profitability of your organization? Generally, what potentially new equipment, facilities and personnel will be needed for the incremental business associated with your project? Does your organization have the proper channel strategy and resources or is your organization in need of a partner?

Regulatory Compliance	Are their aspects of your technology development that are subject to the terms of any export control rules and regulations? Are there any Federal, State/Provincial or local regulatory compliance issues that could possibly impact the global collaboration or data exchange that may be associated with your technology development?
Education	What academic or institutional organizations should be included in the project and what unique skills and capabilities must be created? Have you reviewed the institution's tech transfer list of available IP to see if your project effort could be reduced through a licensing agreement?

These critical success factors are so important to the project that the CANEUS organization includes a Project Support Group for each factor. These groups provide the Project Team with the resources they need to address each item throughout the project definition and implementation process.

5.5 FBW PROJECTS

Following is a list of the FBW Projects that are currently the focus of the Sector Consortium that were selected as a result of the activities from previous workshops.

CANEUS FLY-BY-WIRELESS APPROACH

The Aerospace community overwhelmingly accepts the premise that wireless technologies are a part of the solution to these challenges. However, the diversity of likely use cases, along with significantly varying wireless technologies' complexities, diversity of needed performances, and very often severe environmental requirements, impose a multitude of constraints and difficult-to-achieve needs upon these devices and systems.

The Consortium considers the referenced four FBW Projects as key elements within the CANEUS purview, composed of activities:

- Identifying user needs and technology providers;
- Reviewing the current state of the art w.r.t the four identified projects;
- Matching users (those with needs) with providers (technology, intellectual property, capability); and emphasize the supply chain
- Mapping this need-supplier matching to specific new technologies or devices to develop the specific Project Plan;
- Folding the specific project into the envisioned strategic CANEUS FBW portfolio and Strategic Plan.

5.5.1 STRUCTURAL VEHICLE HEALTH MONITORING

Mission & Vision Statement

To realize mature MNT and SHM technologies, devices and systems coupled with new methods in systems engineering processes, management and engineering techniques that utilize wireless interconnectivity.

Therefore we may best consider the Fly-by-Wireless SHM Project as a key project within the CANEUS Fly-by-Wireless Sector Consortium that are composed of activities:

- Identifying needs. Reviewing the current state of the art w.r.t. SHM and / or wireless technologies;
- Matching users (those with needs) with providers (technology, intellectual property, capability);
- Mapping this need-supplier matching to specific new technologies or devices to develop
- Generation of the specific Project Plan;
- Folding the specific project into the envisioned strategic CANEUS FBW portfolio and Strategic Plan

In order to achieve these objectives, formal surveys and /or funded studies (including Cost-Benefit) may be initiated by CANEUS, with the consent of the Sector Consortium. Immediately at the upcoming FBW09 workshop, we envision that the FBW sector Director will hold ad hoc Voting on all previously proposed and newly (during the sector meetings) proposed FBW SHM potential projects to lead the working body to a forced-consensus on activities to be funded.

Each potential FBW-SHM project will be scored and weighted-by-agreement by the attendees.

Potential FBW SHM Project Topics include:

- Appropriate wireless technologies for Engine Structure SHM, including high-temperature elements
- Appropriate wireless technologies for both fuselage and wing elements SHM
- Appropriate wireless technologies for tank elements SHM
- Systems aspects for FBW SHM
- Programmatic aspects of FBW SHM
- Project Management aspects of FBW SHM
- New Engineering Tools aspects of FBW SHM

Background

Aging aircraft and perhaps more importantly new aircraft and spacecraft, increasingly employing composites, gossamer or lightweight structures, advanced metallurgies, in new, conventional and increasingly in harsh environment applications, require revised approaches to Structural Health Monitoring. These additional equipment, material and structure monitoring, diagnostics and prognostics require a higher order of magnitude in complexity, scope and in the sheer numbers of sensing elements. The Aerospace community overwhelmingly accepts the premise that wireless technologies are a part of the solution to these challenges. However, the diversity of likely use cases, along with significantly varying wireless technologies' complexities, diversity of needed performances, and very often severe environmental requirements, impose a multitude of constraints and difficult-to-achieve needs upon wireless VSHM.

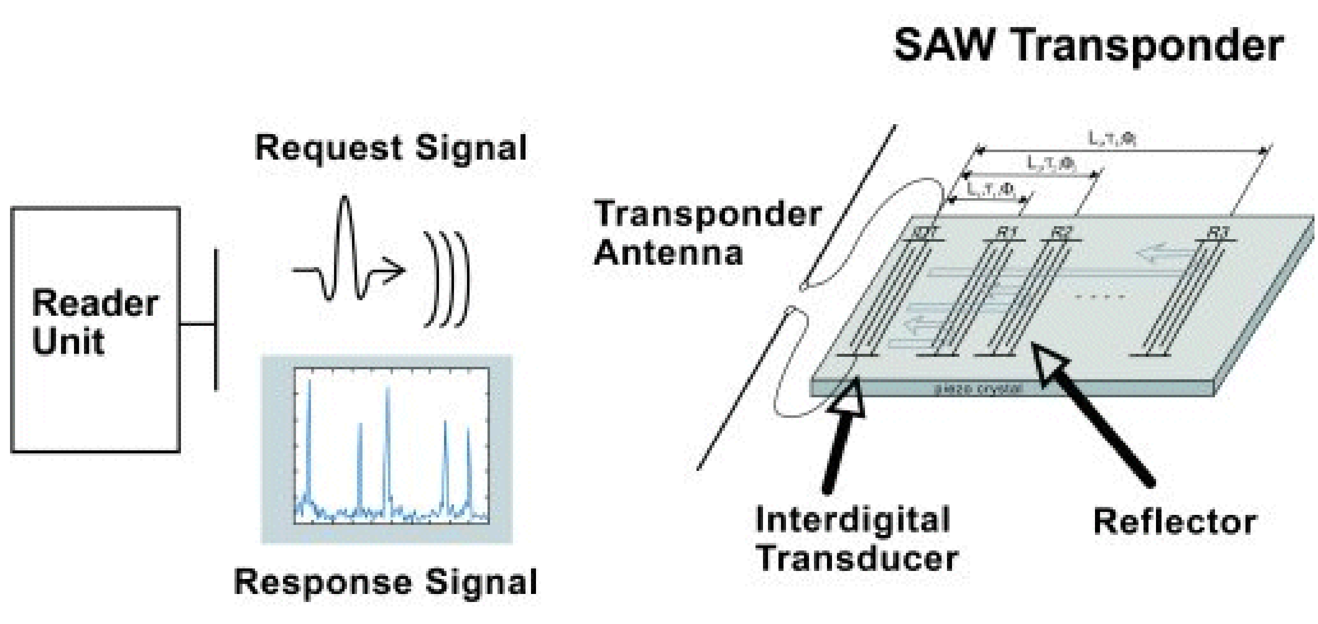
5.5.2 PASSIVE SENSOR-TAG SYSTEM

Mission & Vision Statement

To realize mature MNT and Passive Wireless Sensor Tag technologies, devices and systems coupled with new methods in systems engineering processes, management and engineering techniques that utilize wireless interconnectivity.

Background

Aging aircraft and perhaps more importantly new aircraft and spacecraft, increasingly employing composites, gossamer or lightweight structures, advanced metallurgies, in new, conventional and increasingly in harsh environment applications, require revised approaches to Structural Health Monitoring. These additional equipment, material and structure monitoring, diagnostics and prognostics require a higher order of magnitude in complexity, scope and in the sheer numbers of sensing elements. The Aerospace community overwhelmingly accepts the premise that wireless technologies are a part of the solution to these challenges. However, the diversity of likely use cases, along with significantly varying wireless technologies' complexities, diversity of needed performances, and very often severe environmental requirements, impose a multitude of constraints and difficult-to-achieve needs upon Passive Wireless Sensor Tags.



Passive Sensor Tags Utilizing SAW Technology:
Surface Acoustic Wave (SAW) tags do not contain a battery or an IC chip. The tags are completely passive, and transmit information simply by reflecting energy back to the reader. SAW tags have no memory but can be interrogated at far lower received power levels (hence far longer ranges) than IC-based tags. In addition, the tags have some inherent sensing capabilities. The operation of a SAW tag is illustrated here.

As the figure indicates, a pulse transmitted by the reader is received at the tag antenna and converted into an acoustic signal by the inter-digital transducer (IDT) connected to the antenna. The acoustic signal propagates as a compression wave along the surface of the piezoelectric tag substrate and is partially reflected back to the IDT at each of the reflectors etched onto the substrate. When the reflected pulses reach the IDT, they are converted back into electrical signals and re-radiated from the antenna as a sequence of pulses that constitutes the impulse response of the tag. The relative timing and/or phase of the sequence of reflected pulses encodes the ID of the tag and is determined by the position and reflection coefficient of each of the tag reflectors.

The impulse response of a SAW tag changes in response to both the temperature of the tag and the stress on the tag substrate. Hence, the tag can be used to sense both temperature and stress. The temperature sensing modality is common as well as strain modality.

The temperature of a SAW-based Passive Sensor Tag can be estimated by direct measurement of the time dilation (or contraction) of the tag impulse response. In an alternate manner, strain may be accurately determined.

This initiative aims to focus on developing a many-channelled system that requires no wires with applications for the commercial aircraft fleet based on perceived high market demand in non-aerospace fields. It aims to increase accessibility of data acquisition while reducing the cost of system test and verification, increase passive sensor performance by enabling high frequency readout, and decrease parasitic effects and assembly challenges for a variety of applications, including traffic, biomedical, and automotive sensors.

5.5.3 SENSOR-DAQ MICRO-MINIATURIZATION

Mission & Vision Statement

To realize mature MNT and Wireless Sensor - DAQ Micro-Miniaturization technologies, devices and systems coupled with new methods in systems engineering processes, management and engineering techniques that utilize wireless interconnectivity.

Vision Statement Elaboration

New designs of aircraft and spacecraft require large amounts of data gathering for in-flight validation. The precursors to these normally-flown onboard, highly miniaturized and wirelessly enabled DAQ systems may be termed Low Mass Modular Development Flight Instrumentation Systems (LMMDS). This Vision Statement is intended to identify Low Mass Modular Development Flight Instrumentation Systems (LMMDS) that can provide the capability to optimize the number and quality of measurements made per flight at a reduced life cycle cost as compared to conventional data gathering systems.

This, as a potential CANEUS project, focuses on low mass, highly modular, non-critical flight data gathering and processing technology that could be integrated into upcoming development tests as well as the operations of future aircraft and aerospace vehicles.

Development Flight Instrumentation Systems (DFI), are systems intended to collect data which is primarily intended for validation of vehicle systems, environments and operations and models/assessments of them. DFI data may be relied on for critical analyses/decisions for future flight tests and missions but will not be used directly for critical decisions on the mission they fly on. DFI systems may also be thought of as precursor / prototype systems and their mission performance a validation or technology readiness level step towards the system use in more critical applications.

Sensor Applications: - Vehicle systems / structure - Environments - Crew/Ops - Flight Tests / Payloads / possibly experiments - System Growth: - Capability to increase the number of sensors or system applications - Sensor installation interfaces: - From Non / Velcro to Bond-on / Embedded - Sample Rates: - From very high to very low - Mission Data transmit needs: - None to very high (short bursts) - DAQ Complexity: - Continuous sample-store to Triggered / Scheduled / Commanded - Data will have to be recorded either by LMMDS or through interface with vehicle recording capability - DAQ Types Supported: - Passive Tag interrogators to multi-channel systems with synchronization provided by the network of DAQ / Loggers themselves - integrated with or separate from the vehicle - Sensor type: - From sensors that could be matured for use in safety critical applications to sensors that could support science experiments onboard spacecraft- Data Processing / Reduction: - From none to summary data files to answers at the DAQ - Data Synchronization: - Data from LMMDS will be time synchronized as needed - System life: - Ranges from short (e.g. pre-launch / pre-take-off events) to long (e.g. contamination or deterioration sensing over the life of the vehicle).

Technology Objectives

The following list shows some examples of these technologies, but is by no means intended to be an exhaustive list.

1. Micro-size and minimum weight, including connectivity.
2. Very low power, low maintenance, long-life between servicing.

3. Least number of wires/connectors required, including wireless or no connectivity.
4. Minimum integration and operations to achieve for modularity.
5. Smart DAQs with User Specifiable calibration, scheduled and even-triggered modes.
6. Smart DAQs with Processing / Storage allowing reduction of total data transfer.
7. Robust/Secure Wireless networking and synchronization between DAQs and even between sensor and DAQ.
8. Plug-and-play wireless interoperability.
9. Plug-and-play DAQ to avionics integration.
10. Open architecture standards to promote multiple vendors with competitive solutions.
11. Wide variety of data acquisition rates - 1 sample per hour to 1 mega-sample / sec
12. Robustness with respect to projected environments.
13. Wide variety of sensor types, including: temperature, dynamic and quasi-static acceleration, dynamic and static strain, absolute and dynamic pressure, high rate acoustic pressure, calorimeters, dosimeters, radiometers, shock, air flow, various hand-held sensors etc.

5.5.4 WIRELESS SYSTEMS IMMUNITY IN ELECTROMAGNETIC ENVIRONMENT (HIRF, LIGHTNING, ETC)

Aircrafts are more and more relying on systems to perform functions which are necessary for the continued safe flight and landing. Moreover the electronic components of those systems become smaller and smaller and consume less and less energy, which makes them very sensitive to electromagnetic hazards: Lightning, HIRF, ESD, LIRF...

Aircraft systems are interconnected by cables that in addition of being vehicle for signal propagation, they also favor the propagation of unwanted energy that may lead to electromagnetic interferences (EMI) for electronic and electrical equipment.

Systems protections depend on aircraft equipotential ground plane, and skin faraday cage effect. In less conductive structure aircraft, lightning induced currents and voltages may increase substantially in bundles and systems in comparison to all metal aircraft. The protection to mitigate the related risk, generally consists of solutions that impacts the weight saving. Less wiring onboard aircraft could contribute to the reduction of conducted susceptibility, conducted Emission, as well as cross talk effects.

With wireless systems, the electromagnetic susceptibility will only be by radiation through the system casing opening. Wireless systems will need specific frequency spectrum that will drive their bandwidth: the higher the frequency, the larger the bandwidth will be for the data transmission. However the emissions from high frequency systems decrease less than those related to low frequency systems. Therefore for a small or medium fuselage aircraft, wireless with very high frequency functionality may lead to several waves' reflections inside the airframe with some risks.

Moreover, risks for front door coupling with communication and navigation antennas located on aircraft fuselage, as well as risks for intermodulation should not be neglected, because they may be aircraft safety related. Even though we are adopter of new technologies, the above concerns is for us as airframer, a way to remind that a lot of work is still needed from scientific community for wireless systems to comply with rules that guarantee aircraft safety.

5.5.5 LESS-WIRE ARCHITECTURES

Objective

To realize mature MNT and "Less-Wire" technologies, devices and systems coupled with new methods in systems engineering processes, management and engineering techniques that utilize wireless interconnectivity.

Background

Future aircraft and spacecraft simply cannot continue following the historical exponential rise in wiring complexity and mass as they have been doing for the past 30 years. As avionics, data handling and command and control elements become more intelligent, capable, and complex, yet increasingly dense and miniaturized; following mere convention in point-to-point wiring, in lieu of a multi-drop or networked design for literally thousands upon thousands of measurement and control points is sheer folly. There is need of new concept wired "Less-Wire" architectures development, both separately, as well as in concert with wireless command and control.

6.0 CANEUS Project Support

6.1 STRUCTURE

6.1.1 BACKGROUND

The CANEUS Organizational Structure is very lean having only two functional levels – Project and Project Support. This structure is very much in keeping with the concept of a "virtual organization" with its multiple lines of communications but at the same time without complexity and extensive infrastructure. The typical characteristics of a Virtual Organisation include minimal administrative infrastructure and facilities. What makes this support structure unique is that it not only emphasizes project oriented development but ensures **intra-project coordination** and collaboration.

As opposed to the informal networking activities used by other technology development associations, the intra-project coordination promulgated by the Project Support structure is a formal and managed process. Not only does the Project Support Groups manage the intra- project coordination, they also provide the support the individual project teams need to manage their critical success factors.

6.1.2 OVERVIEW

With the project support structure of the CANEUS Organisation (Figure 6.1), projects are the main focus. Project support and administration are then the secondary functions of the system. As the diagram illustrates, the hierarchy is virtually flat and thereby promotes direct communications between teams and project support groups. Now, every entity has equal access to the lines of communication.

The advantage of such a structure is the malleability and opportunity for growth within the framework. The structure can grow or contract as the Projects of CANEUS change. All functional entities in the structure are populated and managed by CANEUS Members except for a few positions filled by CANEUS support staff.

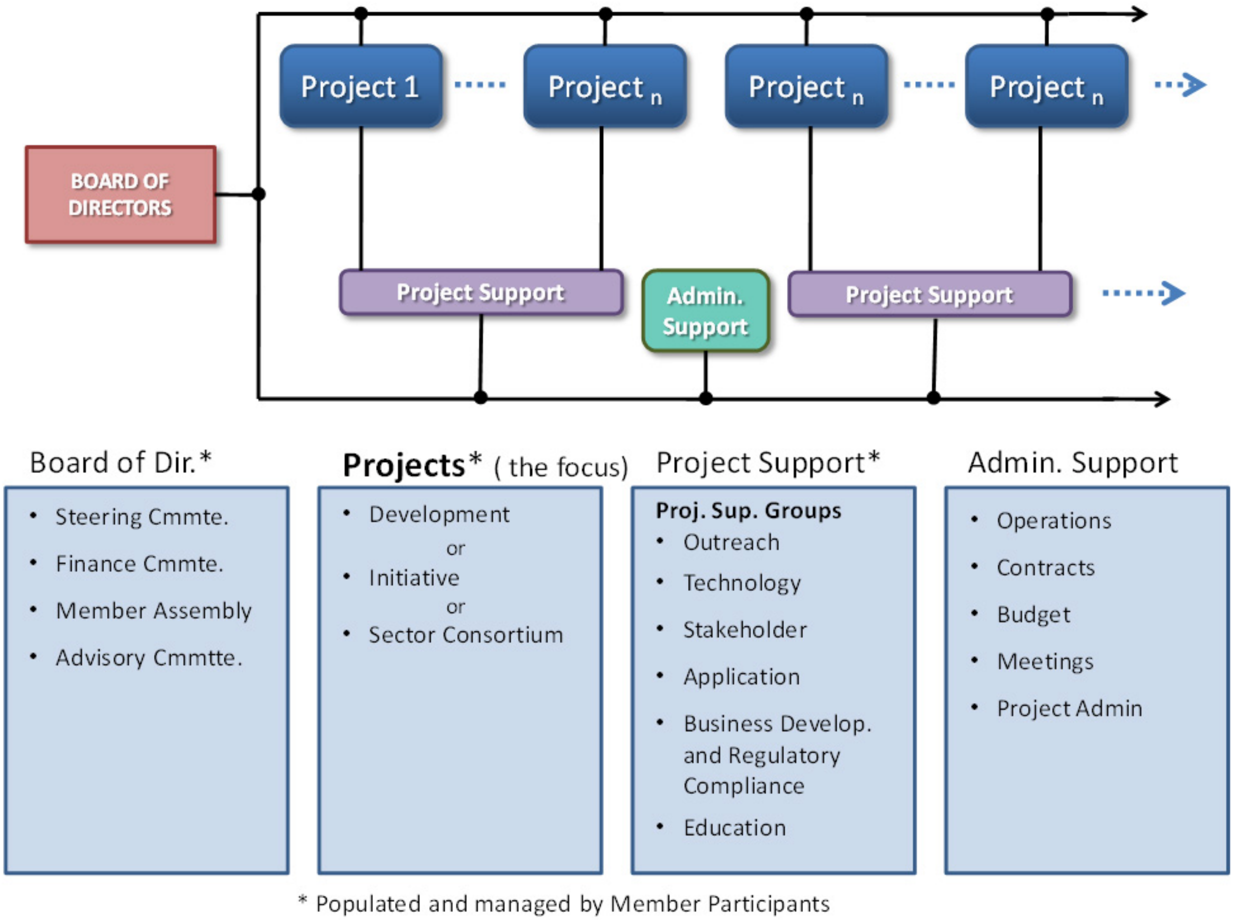


Figure 6.1. CANEUS' Organization Structure

6.1.3 PROJECTS

The CANEUS Organization centers on MNT projects. The other parts of the organization exist to support the definition, implementation and execution of compelling and commercially viable projects. Each Project Team is able to directly communicate with other Project Teams and/or administration without going through an extensive hierarchy. Other technology development associations typically treat each member as a separate project but this has been shown to be less effective than facilitating long lasting business relationships among member partners that are supply chain oriented.

Members of Project Teams are not only part of development project, they also become an advisor to the other teams thus allowing each organization within CANEUS to extend their influence in all areas that are strategically important to a member.

6.1.4 PROJECT SUPPORT

Highly specialized CANEUS MNT projects are typically high risk and high cost. Therefore in order to be cost-effective and minimize risk, the Project Support structure provides leverage with the formally managed intra-project coordination and by providing resources for each of the Project Team's critical success factors. Also, every Detailed Project Plan contains a section for each of the critical success factors therefore each success factor is supported by a group called a Project Support Group or PSG (refer to figure 6.1). The Project Review Committee is in fact, made up of the leaders of each of these Project Support Groups.

The PSGs include the coordination of unique resources for projects of similar types, and the sharing of resources unique to their focus area. This may include the allocation of people such as industry experts, resources, methods, and policies.

Essentially, the PSGs play two roles in the project support function:

1. They sponsor a group of projects that share a common background or theme;
2. They provide critical success factor support for each project

Project Support Groups

a. **The Outreach Group**, comprised of a Leader, and any number of members having an interest in the subject matter. The Project Leader, with assistance from the other sitting participants directs membership recruitment and relationships, interfaces with Sector Consortia and projects teams to help identify external efforts that are parallel to the project activity, and manages: interaction with other conferences, relationships with other industry associations or institutions, relationships with industry standards organizations, and matters pertaining to the organization's marketing, promotion, and web site content.

b. **The Technology Group**, comprised of a Leader, Sector Consortia Directors, and Project Team Leaders, is responsible for facilitating all cross cutting technology based projects, establishing technology based Sector Consortia, assembling CANEUS Strategic and Annual Work Plan input for the Steering Committee and collaborating with the Application and Stakeholder Project Support Groups providing input for Project Plans. Micro and nano technology impacted technology areas that may give rise to projects include but are not limited to: materials, electronics, controls, sensors, power, optics, fluids, processes, and quality systems.

c. **The Stakeholder Group**, comprised of a Leader, Sector Consortia Directors, and Project Team Leaders, assembles a supply chain from CANEUS membership and is responsible for facilitating all stakeholder based projects, establishing stakeholder based Sector Consortia, assembling CANEUS Strategic and Annual Work Plan input for the Steering Committee, and collaborating with the Technology and Application Project Support Groups providing input for Project Plans. Stakeholders include but are not limited to: end users, systems integrators, component suppliers, process suppliers, agencies, and academia.

d. **The Application Group**, comprised of a Leader, Sector Consortia Directors, and Project Leaders, is responsible for facilitating all cross cutting application based projects, establishing application based Sector Consortia, assembling CANEUS Strategic and Annual Work Plan input for the Steering Committee, and collaborating with Technology and Stakeholder Project Support Groups providing input for Project Plans. Micro and nano technology embedded application areas that may give rise to projects include but are not limited to: aircraft, air frame, fight controls, avionics, propulsion, accessories, space, satellites, manned vehicles, and cargo.

e. **The Business Development / Government Regulation Group**, comprised of a Leader and Project Leaders, is responsible for supporting development of Project business cases, providing Member business evaluation services, providing IP valuation and brokering services, developing the organization's Investment Fund, managing new business start-up processes, managing syndicated investment funding for projects, establishing innovation policies and procedures, and infusing innovation practices into project development.

f. **The Education Group** comprised of a Leader and Project Leaders, is responsible for establishing an academic global network of micro and nano technology capabilities related to the aerospace market, a curriculum of micro and nano technology courses that support aerospace applications, a global web portal of academic capabilities for aerospace applications and related technologies, and a global student web portal for aerospace related opportunities. It is also responsible for developing a harmonized technology transfer policy for spin-off intellectual property.

6.1.5 ADMINISTRATIVE SUPPORT

Again, functioning on a horizontal hierarchy stands the Administrative Support Group. This team is essentially responsible for program administration, contracting, budget management, and organizing meetings. As illustrated by the figure, the Admin team is not only located between project support groups but has direct communication lines with all projects involved via those support groups.

6.2 ISSUES

6.2.1 FUNDING MECHANISM

Overview

The goal of CANEUS International is to support the definition and execution of MNT projects important to the consortia project team members. Therefore, CANEUS needs to ensure that requisite funds are in place in order to support the administration and definition process, and the work program of each project.

The CANEUS funding mechanism consist of: (a) consortium membership dues to cover the cost of administration and project definition phases, and (b) funding obtained through in-house funds from agencies and/or those institutions or by taking advantage of open solicitations for the project.

All funding decisions are strongly influenced to maximize the return on investment (ROI) for the consortium members. It is the responsibility of CANEUS organization to develop the most compelling Project proposals that respond directly to the needs of the Aerospace community.

Sponsored Programs

CANEUS will actively campaign with various aerospace agencies and institutions to establish funding for a program with a MNT scope that is critically important to those agencies or institutions. The funds would be doled out by CANEUS to support Member projects that are responsive to the define program scope.

Solicited Project Funds

CANEUS will take compelling Project Concept Proposals and facilitate the Project Proposal Campaign to acquire funding from open competitive solicitations such as broad agency announcement or call for proposals for example.

Unsolicited Project Funds

CANEUS will take compelling Project Concept Proposals and facilitate the Project Proposal Campaign to acquire funding from agencies or institutions through direct inquiries with Program managers from those agencies or institutions that have areas of interest that require solutions which CANEUS and it members are able to provide.

Member Match

Whatever the total cost required is to complete the development and commercialization of a project or service, CANEUS will extract funds from all the applicable/interested sources. If a particular source requires in-kind match to qualify for the funds, CANEUS will coordinate the project team member's resource contribution

Income from Operations

Funds that come into CANEUS from revenue generating services (for example an international MNT resource web portal), will be made available (minus any program costs) for development projects.

6.2.2 IP FRAMEWORK

CANEUS IP Objectives and Stimulus

By recognizing the somewhat unique requirements of the university, industry and government constituencies, independently and as a collective whole, the broad objectives are:

Firstly, to facilitate the commercialization of results from CANEUS member collaboration and to create incentives for active commercial development, job creation and Aerospace industry expansion. Secondly, to provide incentives for participants to pursue collaborative research and development, leveraging the unique facilities and skills of the CANEUS' member network to obtain commercial applications for the economic benefit of themselves, and the industry. And finally, to provide for an equitable sharing of rewards from commercialization among those that contribute to the invention of MNT related products or services.

Underlying Principles

Essentially, each party owns title to the intellectual contribution they make to the Project development. However, whenever possible, ownership of Jointly Developed IP will be assigned to a single party especially in those instances where the IP plays a minor role in the other Project team members' businesses. CANEUS projects involve both precompetitive and proprietary technology development with the terms of ownership and licensing supporting a supply chain theme that recognizes the role of an end user, system integrator, and suppliers in the distribution of rights to the IP.

Systems integrators that typically have the responsibility for a system solution comprised of a portfolio of Project developments must have enough control of the IP to protect the resulting product from competitive encroachment. As such, supply partners must be prepared to provide exclusive niche market licenses for uniquely configured technologies.

Valuation

The valuation of IP (background and foreground) and licensing terms associated with a Project will be determined prior to Project start and said terms will have to be established for final Project approval. Total royalties will then be capped at a percent of the sell price of the product or process that results from the Project and the Project team will agree on the percentage cap prior to Project start. Intellectual property associated with a particular Project will thus be contained in a Project Teaming Agreement that will be negotiated and signed by all the project team members prior to project start.

When necessary, CANEUS can play the role of broker to streamline the technology transfer process in order to accommodate needs of the other interested members and to maximize the value of technology in other non-aerospace niche market opportunities.

Membership Agreement

It is important to note that the value of a technology is realized only when a commercially viable product/process that utilizes the technology is deployed into the market place. The CANEUS process therefore recognizes that proprietary content is essential for successful products and system solutions.

Membership agreement establishes an umbrella of protection, as well as a continuing "innovation environment" throughout the life of membership. This results in the establishment of non – confidentiality terms. Members must agree to abide by IP general principles which protect new ideas and sensitive information exchanged during Detailed Project Plan phase, which includes typical IP agreement terms with the addition of a royalty/value cap, recognition of a supply chain, a valuation method, and identification and ownership terms for new IP.

Members must acknowledge that all IP terms (including new IP that is going to be created) must be established – title, licensing rights, valuation, remuneration, and terms of internal use and commercial use – must be established before project start.

6.2.3 PROJECT CHARTER AGREEMENT

This document will be provided during the workshop.

6.2.4 EXPORT CONTROL ITAR

Please refer to the CANEUS ITAR Handbook and Security application.

6.2.5 REFERENCES

To be added during the workshop.

7.0 Expected Outcomes from FBW09 Workshop

7.1 END USER BRIEFINGS

Day 1 Expected Outcomes:

After day 1 of the workshop participants should walk away with a clear understanding of the:

- workshop process
- CANEUS vision, mission, and goals
- project developments from past meetings
- relevant funding, IP, and regulatory considerations
- clear understanding of end-user and customer needs as related to:
  - Structural Health Monitoring
  - Passive Wireless Sensor Tag
  - Sensor DAQ Micro-Miniaturization
  - EMC- HIRF
- project concepts/ideas from end-user/customers that could offer potential solutions for identified needs

How do the activities on day 1 relate to the overall workshop objectives?

In order for us to understand how we can work together to establish fundable projects, we must first have a clear understanding of what we are working towards. What is the desired solution?

Having a clear understanding of end-user/customer needs, their desired initial applications, and their idea of potential solutions at the outset will help us to effectively scope project development activities. This will ensure that the projects established on day 3 are able to address a clear need and offer a potential solution to a "real" end-user or customer.

7.2 TECHNOLOGY PROVIDER BRIEFING

Day 2 Expected Outcomes:

After day 2 of the workshop participants should walk away with a clear understanding of the:

- current technology and project developments of relevant Fly By Wireless technology providers
- maturity level of current technology developments
- state-of-the art or bleeding-edge technology concepts

How do the activities on day 2 relate to the overall workshop objectives?

From day 1 we now have a general idea of potential/desired solutions. Before we can work collaboratively to establish projects that address a solution we first need to understand what we are working with. What are the current maturity levels of cutting edge technology developments?

By hearing from technology providers developing new and cutting edge FBW technologies we can avoid re-inventing the wheel and can start to indentify synergies amongst the technology providers that can become part of a solution set.

7.3 PROJECT REPORT

Day 3 Expected Outcomes:

After day 3 of the workshop participants should walk away with a clear understanding of the:

- priority of government programs to fund and procure relevant FBW projects and technology developments
- selection criteria, metrics for assessment, project duration expectations, and transition or infusion strategies for these types of aerospace funding initiatives
- cross agency and international organization core competencies in developing new technology concepts to a proof-of-concept maturity level?
- important considerations regarding IP, moving material, data and products across nations

Additionally, based on the project presentations, participants will be updated on next steps for continued project collaboration, funding, and CANEUS support as well as estimated decision milestones post-workshop.

How do the activities on day 3 relate to the overall workshop objectives?

We now understand what solutions may be desired by end-users/customers (Day 1) and the maturity of currently developing technologies (Day 2). Therefore the “gap” between what customers/end-user want and the ability of current technologies to address these needs can be identified. Teams on day three therefore work towards developing project frameworks that demonstrate the ability to bridge this gap by leveraging the involvement of consortium members including technology providers, end-users, customers, integrators, and other value chain members.

Appendices

A. NEEDS ASSESSMENT (FROM WORKSHOP)

B. TECHNOLOGY ASSESSMENT (FROM WORKSHOP)

C. CANEUS PROJECT CONCEPT PROPOSAL TEMPLATE: DEVELOPMENT

D. CANEUS PROJECT CONCEPT PROPOSAL TEMPLATE: INITIATIVE

E. TRL LEVELS

Development Project for: (list the FBW topic area the project is most relevant to)

PROJECT TITLE: Title of Proposed CANEUS Project

Project Concept Proposal for

FBW09 CANEUS FLY-BY-WIRELESS WORKSHOP 2009
June 8-12, 2009 Montréal, Quebec
www.caneus.org/fbw09

Project Description

Objective/Problem Statement: Simply and clearly describe the basic premise behind the technology development.

Approach: Describe the means and methods of task execution and validation (analytical, testing, etc.). Be sure to include the micro and nanotechnology content.

Challenges: What hurdles are addressed in this project and what is the associated risk with each hurdle?

Applications: What applications will benefit from this technology development?

Replace the box above with representative imagery
Annotate with text if the image is not obvious
Try to use jpg images and limit image size to <1Mb to preserve quad chart emailability

Background

State-of-the-art: What is the state-of-the-art and how does this project build on it. Note the innovation and merits of this work relative to past efforts by others.

Scope: Provide a high level overview of the tasks, and milestones. Include key skills and organizational responsibilities.

Deliverable: List the expected outcomes of the development.

Relevance: Describe why this project is relevant to the FBW Workshop topics. Describe how this work benefits the near and long term needs of the FBW consortium.

Project Execution

Project Team: List the names of the organizations to be partners on the team.

ROM Cost:

Fiscal Year	01	02	03	04
ROM Project Cost ($K)				
Potential In-kind match($K)				

Potential Funding Sources: List funding agencies that have parallel interest to this project and could be sources for supplementary funding.

POC: List name, 7 digit phone # and email address of technical rep.

Last Update: MM/DD/YY

PROJECT TITLE

Project Description (Continued)

Use this space as desired for additional explanation and rationale.

Background (Continued)

Use this space as desired for additional explanation and rationale.

Project Execution (Continued)

Use this space as desired for additional explanation and rationale. Cite the performance metric parameters that will determine success.

Critical Success Factors

Outreach: What other organization have efforts in the same subject area (both in and external to the Aerospace community)? What have other organizations accomplished in the related developments? What organizations can you partner with and what licensing opportunities exist?

Technology: What other complementary technologies are involved or are needed – system solutions come from a portfolio of technologies? What other CANEUS Sector Consortia can benefit from the developments associated with your organization' project? What other complementary technologies or developments that are needed by your project are addressed by the other CANEUS Sector Consortia?

Applications: What other applications can take advantage of the benefit from the project – the more, the better and the stronger the business case? Identify the Aerospace applications that may be able to benefit from your development project. (Refer to the list in the Workshop call for papers.) Identify the other applications outside of the Aerospace market that may be able to benefit from your technology development.

Stake Holders: What groups in the supply chain need to be involved? Identify the customer/end user that is involved or is a candidate to be involved with your development project. Identify the systems integrator responsible for the complete system that incorporates your technology into the final product/process. Identify the other businesses, agencies, or institutions that are or could be part of your project. List the organization and their intended roles and responsibilities.

Business Development: What is the strongest business case that can be made, what project management best practices are required, what regulatory requirements impact the project? Also, fill out the following table.

INCOME PROFILE	FY01	FY02	FY03	FY04
Potential Product Sales ($K)	xxx	xxx	xxx	xxx
Target Cost of Goods Sold ($K)	xxx	xxx	xxx	xxx

What role can CANEUS play in mitigating the risk and improving the profitability of your organization? Generally, what potentially new equipment, facilities and personnel will be needed for the incremental business associated with your project? Does your organization have the proper channel strategy and resources or is your organization in need of a partner?

Regulatory Compliance: Are their aspects of your technology development that are subject to the terms of any export control rules and regulations? Are there any Federal, State/Provincial or local regulatory compliance issues that could possibly impact the global collaboration or data exchange that may be associated with your technology development?

Education: What academic or institutional organizations should be included in the project and what unique skills and capabilities must be created?

If possible, avoid using more than this single additional page beyond the main quad chart.

Last Update: MM/DD/YY

Initiative Type Project for: (list the FBW topic area the project is most relevant to)

PROJECT TITLE: Title of Proposed CANEUS Project

Project Concept Proposal for FBW09

CANEUS
FLY-BY-WIRELESS
WORKSHOP 2009
June 8-12, 2009 Montréal, Quebec
www.caneus.org/fbw09

Project Description

Objective/Problem Statement: Simply and clearly describe the basic premise behind the initiative type project (a white paper, market study, industry position paper, standards development, etc,).

Approach: Describe the work and methods the team will employ to attain the objective. Be sure to include a description of the micro and nanotechnology content.

Outcome: What are the intended outcomes from this project? Describe any challenges that may be involved with the project.

Replace the box above with representative imagery
Annotate with text if the image is not obvious
Try to use jpg images and limit image size to <1Mb to preserve quad chart emailability

Background

Leverage: How does this project build on efforts or investigations pursued by your or other organizations? Note the merits of this work relative to past efforts by others.

Scope: Provide a high level overview of the tasks, and milestones. Include key skills and organizational responsibilities.

Deliverables: List the expected outcomes of the development.

Relevance: Describe why this project is relevant to the FBW Workshop topics. Describe how this work benefits the near and long term needs of the FBW consortium.

Project Execution

Project Team: List the names of the organizations to be partners on the team.

ROM Cost:

Fiscal Year	01	02	03	04
ROM Project Cost ($K)				
Potential In-kind match($K)				

Potential Funding Sources: List funding agencies that have parallel interest to this project and could be sources for supplementary funding.

POC: List name, 7 digit phone # and email address of technical rep.

Last Update: MM/DD/YY

PROJECT TITLE

Project Description (Continued)

Use this space as desired for additional explanation and rationale.

Background (Continued)

Use this space as desired for additional explanation and rationale.

Project Execution (Continued)

Use this space as desired for additional explanation and rationale. Cite the performance metric parameters that will determine success.

Critical Success Factors

Outreach: What other organization have efforts in the same subject area (both in and external to the Aerospace community)? What have other organizations accomplished in the related developments? What organizations can you partner with?

Industry Impact: Describe how this project either provides an Aerospace-wide benefit or addresses any challenge that may impede the approbation of MNT by the Aerospace community.

Stake Holders: Who are the industry groups that are most responsible for the success of this project and therefore, must be represented on the Project Team? Identify the other businesses, agencies, or institutions that are or could be part of your project. List the organization and their intended roles and responsibilities.

Funding: How will this project be supported and what is the potential in-kind contributions from the Team Members/Stakeholders.

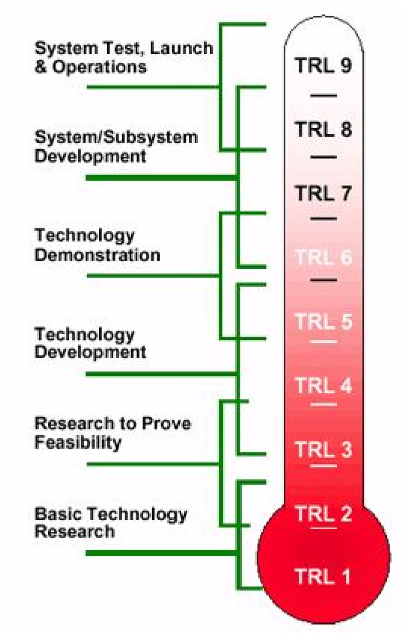
Regulatory Compliance: Are their aspects of your initiative that are subject to the terms of any export control rules and regulations? Are there any Federal, State/Provincial or local regulatory compliance issues that could possibly impact the global collaboration or data exchange that may be associated with your project?

Education: What academic or institutional organizations should be included in the project?

If possible, avoid using more than this single additional page beyond the main quad chart.

Last Update: MM/DD/YY

Appendix E: Technology Readiness Levels



A Technology Readiness Level (TRL) is a measure used by some United States government agencies and many major world's companies (and agencies) to assess the maturity of evolving technologies (materials, components, devices, etc.) prior to incorporating that technology into a system or subsystem. Generally speaking, when a new technology is first invented or conceptualized, it is not suitable for immediate application. Instead, new technologies are usually subjected to experimentation, refinement, and increasingly realistic testing. Once the technology is sufficiently proven, it can be incorporated into a system/subsystem.

Technology Readiness Levels in the National Aeronautics and Space Administration(NASA)
(Source: Mankins (1995), *Technology Readiness Levels: A White Paper*)

Technology Readiness Level	**Description**
1. Basic principles observed and reported	This is the lowest "level" of technology maturation. At this level, scientific research begins to be translated into applied research and development.
2. Technology concept and/or application formulated	Once basic physical principles are observed, then at the next level of maturation, practical applications of those characteristics can be 'invented' or identified. At this level, the application is still speculative: there is not experimental proof or detailed analysis to support the conjecture.
3. Analytical and experimental critical function and/or characteristic proof of concept	At this step in the maturation process, active research and development (R&D) is initiated. This must include both analytical studies to set the technology into an appropriate context and laboratory-based studies to physically validate that the analytical predictions are correct. These studies and experiments should constitute "proof-of-concept" validation of the applications/concepts formulated at TRL 2.

4. Component and/or breadboard validation in laboratory environment	Following successful "proof-of-concept" work, basic technological elements must be integrated to establish that the "pieces" will work together to achieve concept-enabling levels of performance for a component and/or breadboard. This validation must be devised to support the concept that was formulated earlier, and should also be consistent with the requirements of potential system applications. The validation is relatively "low-fidelity" compared to the eventual system: it could be composed of ad hoc discrete components in a laboratory.
5. Component and/or breadboard validation in relevant environment	At this level, the fidelity of the component and/or breadboard being tested has to increase significantly. The basic technological elements must be integrated with reasonably realistic supporting elements so that the total applications (component-level, sub-system level, or system-level) can be tested in a 'simulated' or somewhat realistic environment.
6. System/subsystem model or prototype demonstration in a relevant environment (ground or space)	A major step in the level of fidelity of the technology demonstration follows the completion of TRL 5. At TRL 6, a representative model or prototype system or system - which would go well beyond ad hoc, 'patch-cord' or discrete component level breadboarding - would be tested in a relevant environment. At this level, if the only 'relevant environment' is the environment of space, then the model/prototype must be demonstrated in space.
7. System prototype demonstration in a space environment	TRL 7 is a significant step beyond TRL 6, requiring an actual system prototype demonstration in a space environment. The prototype should be near or at the scale of the planned operational system and the demonstration must take place in space.
8. Actual system completed and 'flight qualified' through test and demonstration (ground or space)	In almost all cases, this level is the end of true 'system development' for most technology elements. This might include integration of new technology into an existing system.
9. Actual system 'flight proven' through successful mission operations	In almost all cases, the end of last 'bug fixing' aspects of true 'system development'. This might include integration of new technology into an existing system. This TRL does *not* include planned product improvement of ongoing or reusable systems.

The CANEUS "Fly-by-Wireless" Consortium is an international forum promoting the advancement of a broad range of wireless technologies for use by the global aerospace industry. Membership in the Consortium includes all the primary industry stakeholders, including new technology developers, system integrators, and aerospace end-users.

The CANEUS "Fly-by-Wireless" Consortium is the steward of the aerospace industry's strategic and technology roadmap for wireless technologies. The CANEUS "Fly-by-Wireless" Consortium has established a collaborative environment wherein resources from member organizations are pooled to focus on high-risk, high-cost initiatives aimed at accelerating the infusion of emerging wireless technologies into aerospace applications.

The Consortium also acts as the broker for licensing intellectual property jointly developed by its collaborative consortia. System integration efforts focus on the development of the appropriate supply chain organizations. The CANEUS "Fly-by-Wireless" Consortium is the premier advocacy group addressing FAA regulations, the development of standards and certification requirements for RF/EMI/EMC, and RF spectrum management. The Consortium would also manage an industry portal for members' technologies.

In summary, the CANEUS "Fly-by-Wireless" Consortium is chartered with creating and sustaining the entire "ecosystem" for wireless technologies for aerospace applications. Beginning with a strong participation by worldwide end-users, the Consortium will establish a robust supply chain to sustain the entire technology development pipeline. Partnership with key sponsoring agencies is critical. For example, in the USA, the CANEUS "Fly-by-Wireless" Consortium will partner with agencies directly involved in aerospace activities such as the FAA, NASA, DOD and DARPA, as well as agencies that are connected peripherally to aerospace activities such as NIST, NSF, DOT and NIH. Spin-off applications into other market sectors such as the petroleum and chemical industries; rail transportation, automotive and biomedical sectors will also be actively pursued. The following "Focus Areas" have been identified for initiating technology development projects.

CANEUS "Fly-by-Wireless" Consortium Major Topics of Interest:

- Sensor DAQ Micro-Miniaturization
- Passive Wireless Sensor Tag
- Less–Wire Architectures
- Structural Health Monitoring
- Wireless systems immunity in Electromagnetic Environment (HIRF, Lightning etc)

CANEUS "Fly-by-Wireless" Consortium Focus Areas

- System Engineering and Integration to reduce cables and connectors in aircraft and spacecraft
- Modular and accessible wireless architecture
- International Spectrum usage for use of On-board Wireless

CANEUS "Fly-by-Wireless" Consortium Invited Organizations

Founding organizations for the CANEUS "Fly-by-Wireless" Consortium include:

- CANEUS International
- CANEUS USA Inc.
- NASA
- Bombardier Aerospace
- NRCC
- Boeing Corp.
- LMCO
- DRDC-DND

- Pratt & Whitney Canada
- Canadian Spaced Agency
- Embraer (Brazil)

Benefits of Participation in the CANEUS "Fly-by-Wireless" Consortium

Participating members as well as institutions are assured of the following benefits:

- Cost and risk mitigation: Access to jointly developed pre-competitive technology and proprietary product development
- Participation in collaborative technology, product and business development environments
- Licensing access to a fair and equitable IP-brokering service
- Reduced time-to-market and rapid system-level product deployment through supply chain collaboration
- Participation in the development of global standards in cooperation with leading aerospace corporations and agencies worldwide
- CANEUS-mediated "harmonization" of various national policies controlling collaborative international technology development
- Access to CANEUS forums/conferences as key networking platforms for members to address relevant issues
- Access to CANEUS' global "technology portal" that identifies state-of-the-art wireless technologies as well as the technology developers and suppliers

CANEUS "Fly-by-Wireless" Consortium Structure, Scope and Funding:

CANEUS Consortia operate semi-autonomously with oversight from the parent CANEUS organization. Thus, the CANEUS "Fly-by-Wireless" Consortium will be responsible for electing an Executive Board for managing the Consortium's various activities. The Board working in conjunction with the membership will appoint sub-committees responsible for the various thrusts that the CANEUS "Fly-by-Wireless" Consortium undertakes. Examples of such sub-committees include: Standards, R&D Requirements, Investments, Technology Roadmap, Industry Portals, and Industry Outreach sub-committees. The primary organization within the Consortium that recommends the formation of these sub-committees is the Stakeholder committee. The Stakeholder committee is derived from among the Consortium membership and has representation from the technology developers as well as the product-manufacturing supply chain.

The CANEUS "Fly-by-Wireless" Consortium will initiate new collaborative Projects in each of the "major Topic" and "Focus Areas" identified above. The funding for each Project is derived from a combination of funding from sponsoring agencies and from the Consortium membership. Project funding constitutes 88% of the total expenditures of the CANEUS "Fly-by-Wireless" Consortium with 12% of the total expenditures being reserved for administrative overhead.

About the CANEUS Organization:

CANEUS (www.caneus.org) is a global non-profit organization serving the needs of the aeronautics, space and defense communities by fostering the coordinated, international development of MNT (Micro-Nano-Technologies) from concepts to systems. As a "hands on" organization, CANEUS is focused on the practical aspects of transitioning MNT rapidly and efficiently, by bringing together technology developers, aerospace end-users, governmental policy makers and investors across the world.

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