# Multi-Mission Ordering Planning R&D Tool



## Third International SAR Workshop

### ICGS-SAR


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**Developed by MDA Space under CSA contract**

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# Motivation

Initial motivation for the development of the R&D tools:

- Simplify user task to order and access data
- Evaluate efficiency of combining multiple source of data

However, R&D tools have added benefits to:

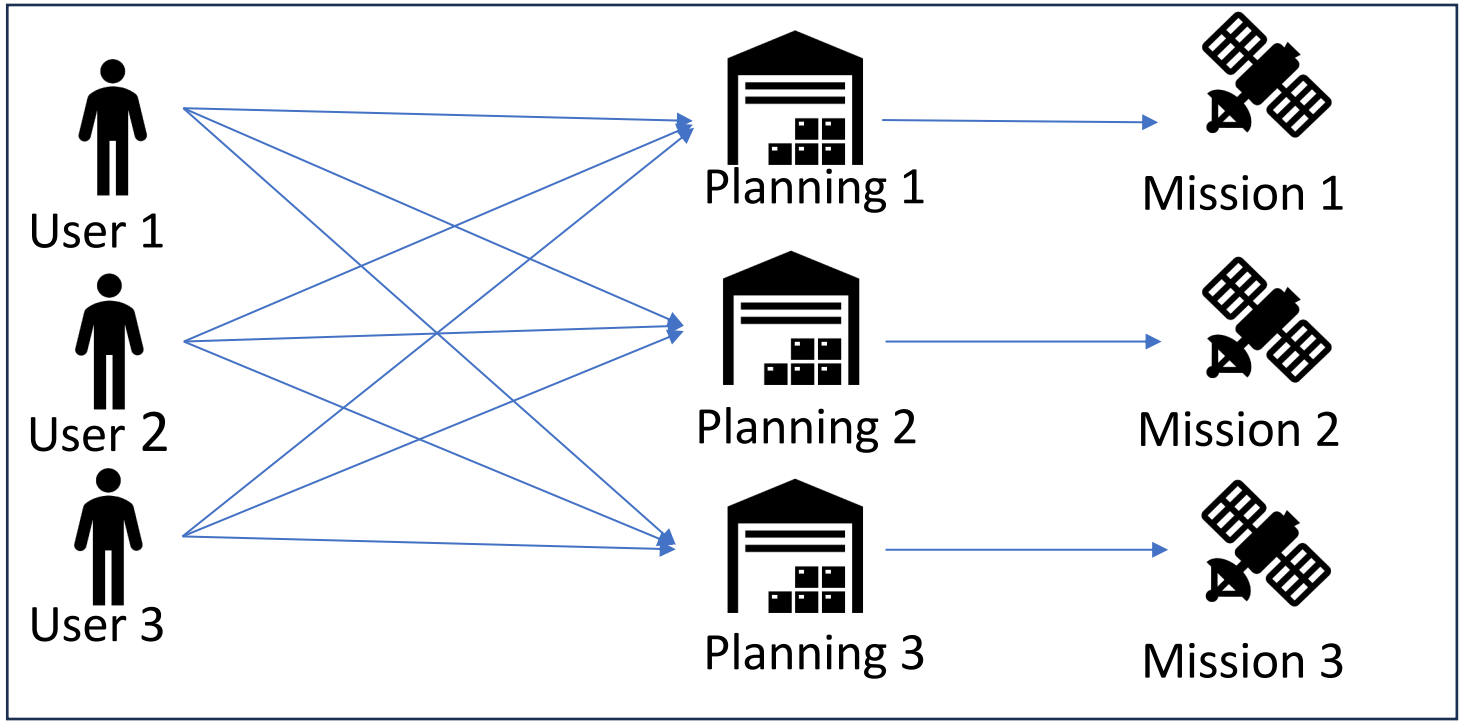
- **Understand interaction between existing and future SAR System**
- **Optimize coverages of multiples SAR system**

Validate interest in such tool to evaluate different coordination scenarios?



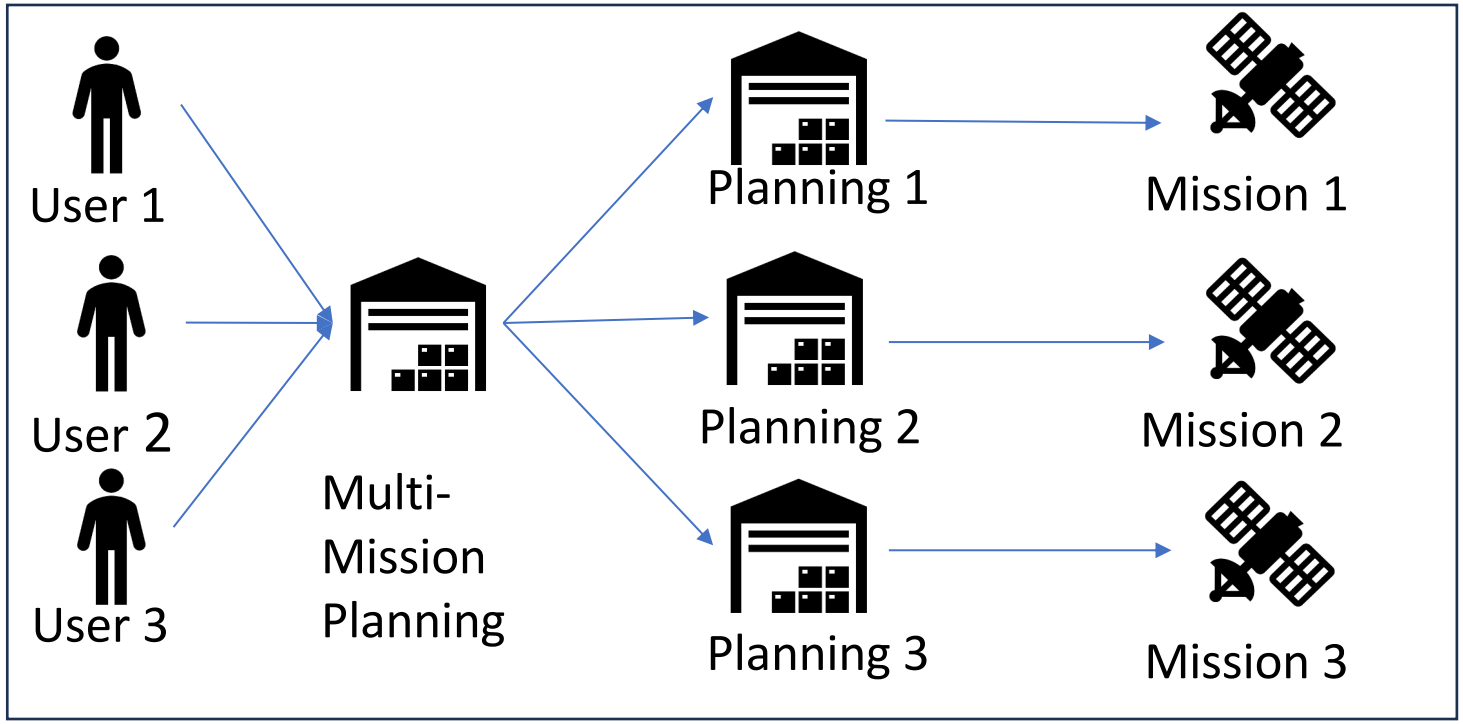
# Challenges in planning data acquisition

- Multiple source of data, Multiple User Orders challenges:
  - Multiple acquisitions within small time window
  - Sub-optimal coverage
  - Conflict within User Orders
  - Complex for Users
  - Highly complex to try to optimize coverage plan of multiple mission



# Multi-Mission Ordering Planning Tool

- CSA contracted MDA Space to develop a Multi-Mission Ordering Planning R&D Tool.
- Evaluate benefits of better coordination between RCM acquisitions, fixed S1 acquisition plan, commercial data purchase and eventually successor to RCM.
- Provide coherent set of requests, within a specific resource allocation to speed each mission planning effort.



# Capabilities

- Type of tasking
  - Single tasking
  - Standing (recurring) tasking– once every day for example
  - Concurrent tasking – e.g.: C and L band acquisition within a 2 hours time window (only work for single order)
  - Cross cueing tasking tasking – e.g.: tasking X-Band satellites after a C-Band wide area image being acquired and analysed.
- AoI Coverage type
  - AoI based – Coverage is optimized over a specific AoI.
  - Swath Based Order – Users directly select swath of interest.
- Available satellites
  - RCM
  - RADARSAT-2
  - MDA CHORUS
  - ALOS-2
  - SAOCOM
  - Sentinel-1
  - Configurable to add satellites
- Simplified resource model
  - Imaging time: maximum image length, imaging per orbit and average over multiples orbits.
  - Not meant to replace dedicated mission planning
- Possible to ingest pre-defined imaging plan (Sentinel 1)

# Optimization capability

## Offer wide range of optimization algorithms

- Greedy heuristics
- Improvement heuristic and metaheuristic algorithms
  - Local search heuristics
  - Tabu Search methods
  - Variable neighborhood search metaheuristic
  - Multi-phase algorithm (SaAB)
  - Variable Swath Insertion (VSI)
  - Hybrid algorithm (SaAB and VSI)
- Exact optimization (Gurobi)

## Configurable weight for objective function

- Cost (when commercial mission involved)
- Imaging duration
- Opportunity score

# Status and additional capability to be added

- Developed in steps
  - Incorporate feedback from Mission Planners and Users providing requests
  - First complete prototype available
- Additional features and bug fixes underway
  - Ability to add exact repeat cycle for CCD
  - Iterative planning (adding activities after an initial plan is completed)
  - Completion date December, 2024
- Final test to be performed by CSA following initial delivery

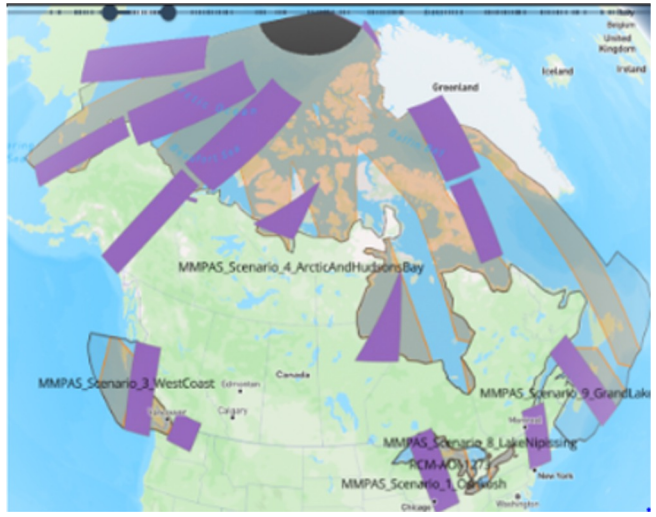
# Example test case

- Canadian Maritime Area of Interest (Sea ice)
- To better illustrate, a single RCM is used, all 3 RCM provide an almost complete coverage
- Preliminary results – some fixes are underway

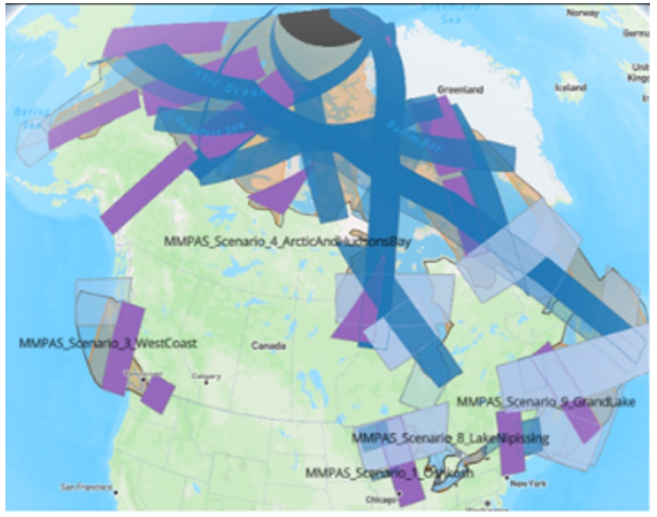
RCM 1 (1 satellite)




RCM 1 + S-1




RCM 1 + S-1 + RADARSAT-2 (dark blue) + MDA CHORUS (light blue)



# Relevance to working group

- Root of software is for Mission Planning
- However, provide simulation tools to evaluate impact of coordinating coverage between mission.
- Could look at what-if scenario
  - Coverage achievable over Arctic if mission X and Y allocate z min of imagery
  - Coverage over Supersite from multiple sensors

# Additional material for splitter session

# Recap/Potential test cases of interest

- MDA Space has developed a Multi-Mission Ordering Planning  R&D Tool under CSA contract
- R&D Tool will be available at CSA
  - Potential to study coordinating acquisitions from multiple missions
    - taking into consideration limits on allocated imaging time of each instrument
- What would be test cases/scenario useful to the working group?
- Could test scenarios with:
  - Division by application
  - Geographical area

# What is needed – define acquisition scenario

- AOI to cover (kml file ideal)
- Image characteristics required (resolution, polarization)
  - Alternatively: List of acceptable modes from each sensors
- Coverage frequency
- Coverage repeat cycle (TBC, under development)

# What is needed – add satellites

- Nominal orbit information
  - Epoch date & time
  - Ascending node
  - Inclination
  - Argument of perigee
  - Orbit period
  - Semi-major axis
  - Eccentricity
  - Mean anomaly
  - Repeat cycle
  - Max image length
  - Switch delay (between images)
- Satellite constraints
  - Max continuous imaging
  - Max imaging per window
    - Window duration
    - Max imagining
- For each mode
  - Elevation angle (near and far)
  - Polarization supported