



Intelligent Power Management for Autonomous UAV Systems

PPEM016

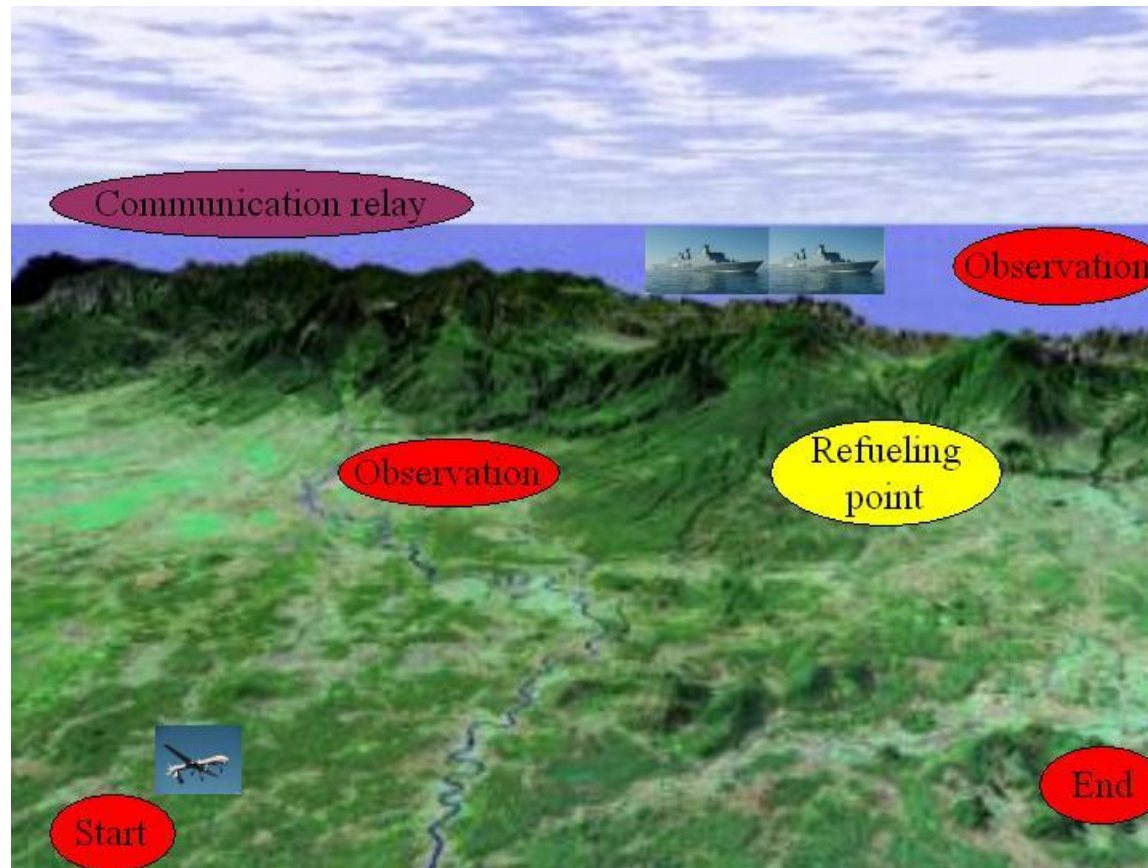
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The UAV Energy Challenge

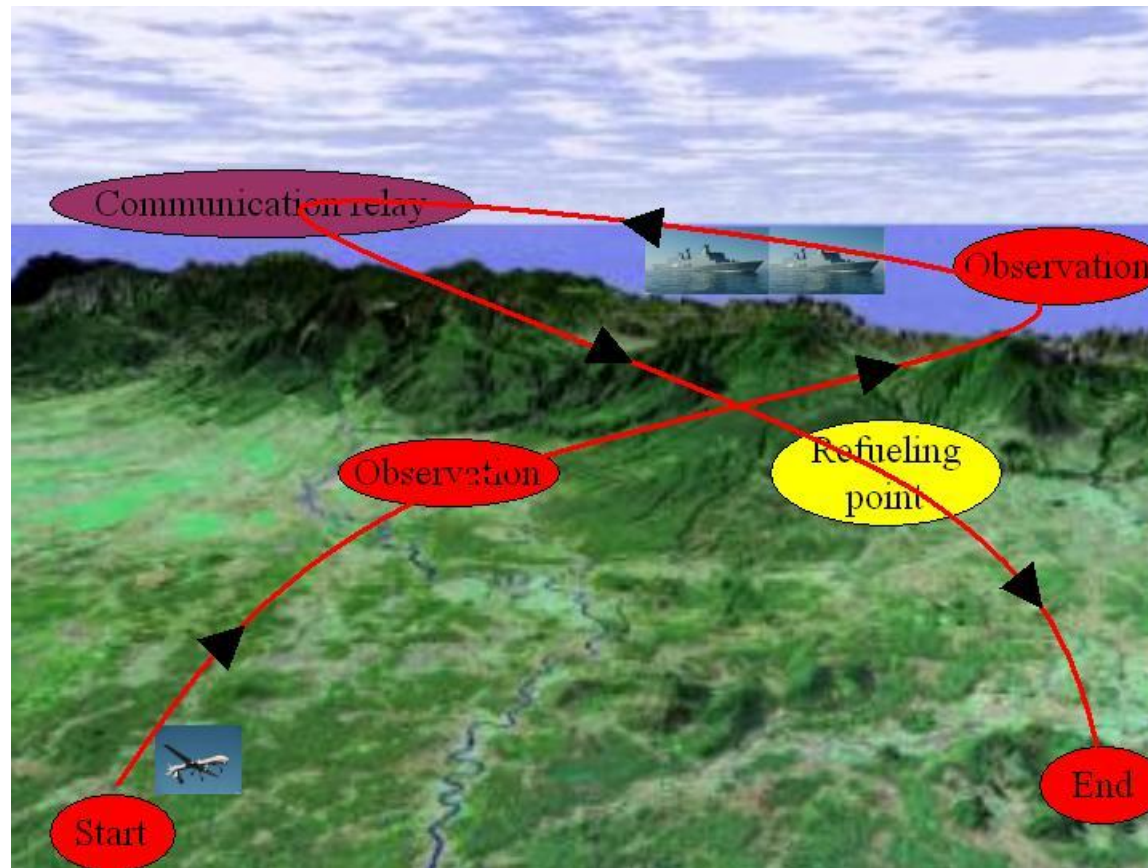
Nowadays UAV's are required to perform various missions, therefore requiring a formal mechanism for allocating the fuelling requirements as a priori and assistance to the mission planners and fuel logistics teams to plan ahead.

There is also a need to increase the endurance without necessarily changing the core UAV technology.

Example Missing Vignette



Minimum Distance Flyable Path



The Challenges of Energy Path

- Can we find an optimum UAV routing in the energy domain?
- What are the implications to UAV design (propulsion thrusters etc)?
- What are the differences and similarities of energy and Euclidean domain solutions?
- What are the benefits of the energy domain?

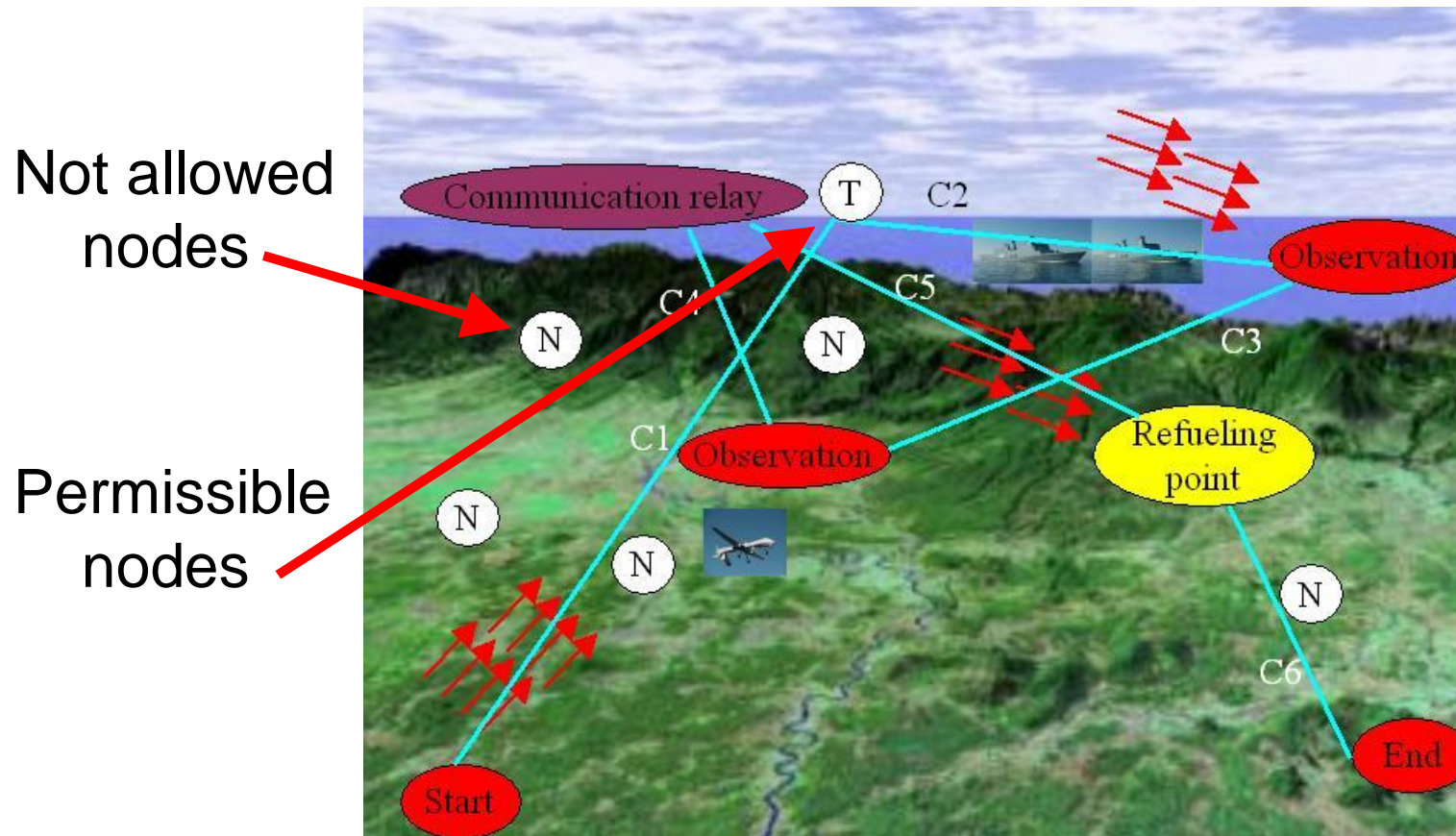
Research challenges

- How can we represent a UAV mission mathematically?
- What tools are available to utilise and solve efficiently the mathematical problem?

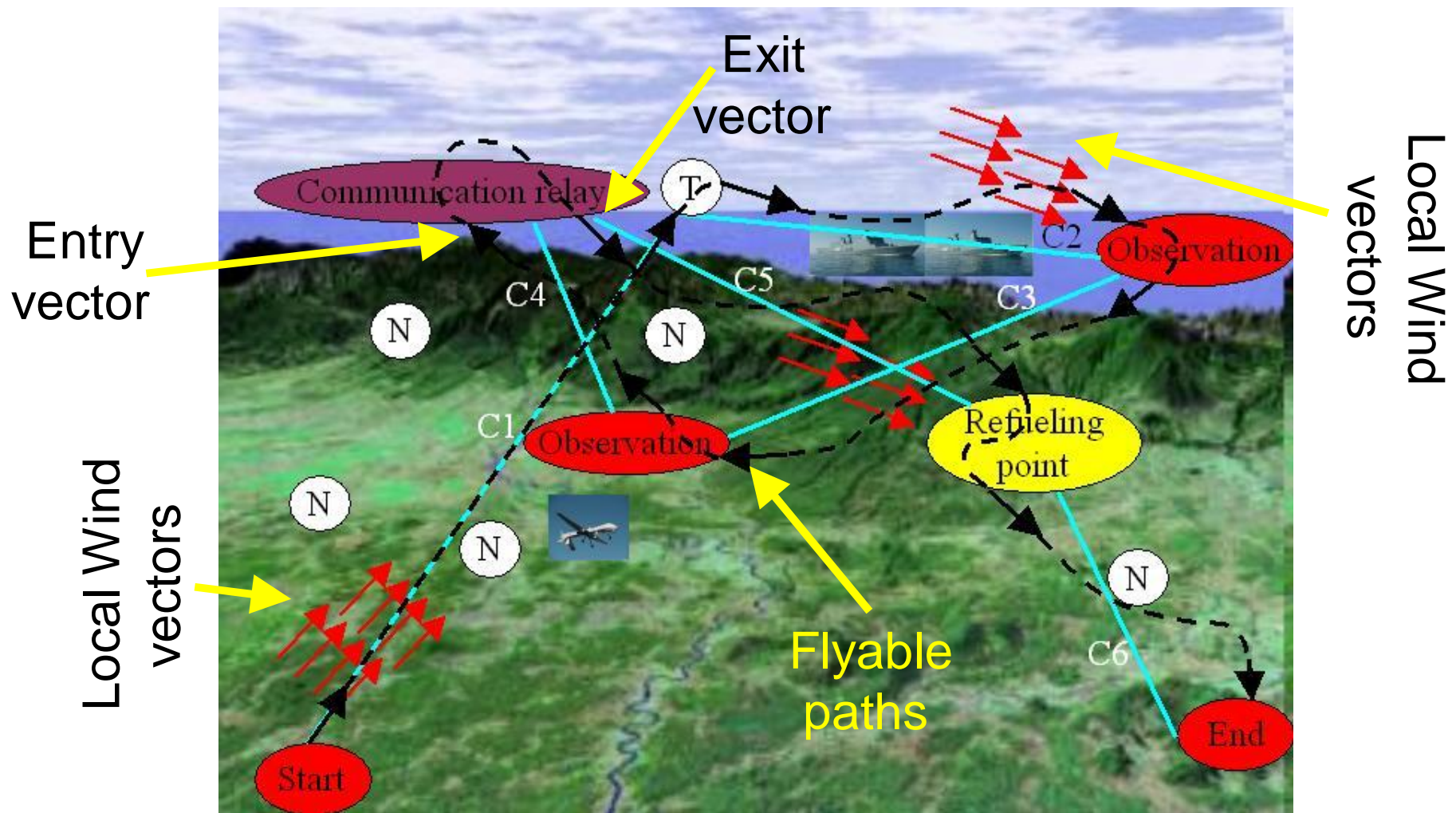
Representing the UAV mission - Example

Node number	Map name	Reasoning
1	Start	UAV start point
2	Observation	UAV must fly over once
3	Refuelling point	UAV may require
4	Observation	UAV must fly over once
5	Communication relay	UAV must pass once to relay information
6	End	Mission completed i.e. data sent and UAV is safe.

The UAV Energy Domain - Connectivity



Energy Domain and Flyable UAV Paths



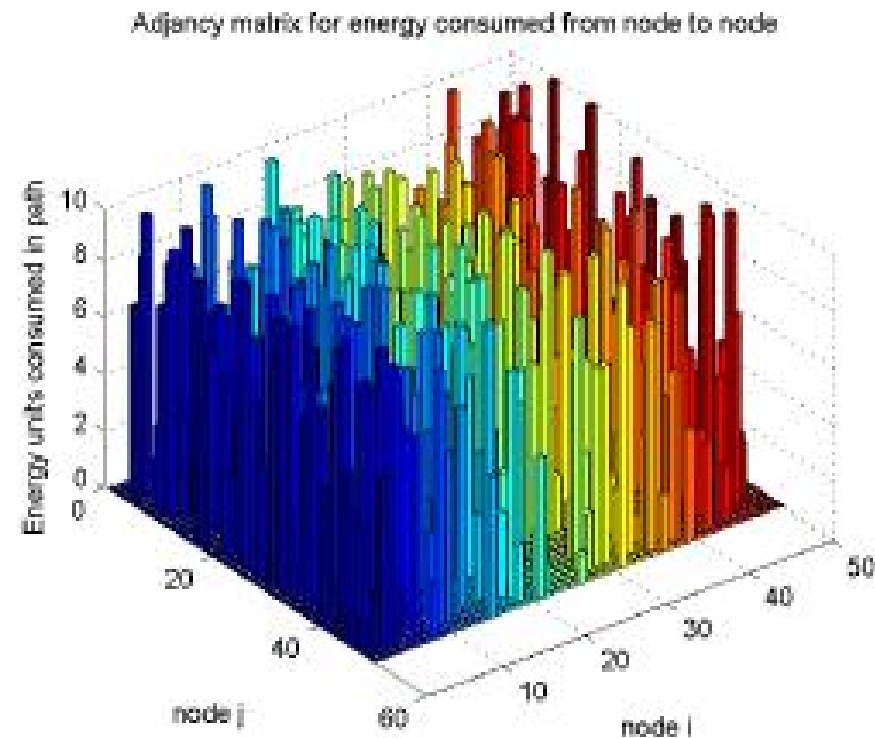
Remarks

Although the route proposed in figure four appears to be longer due to the various constraints and tail and opposing winds it is worth noticing that the actual route itself is more energy or fuel efficient while also satisfying the mission requirements.

The Modelling Process

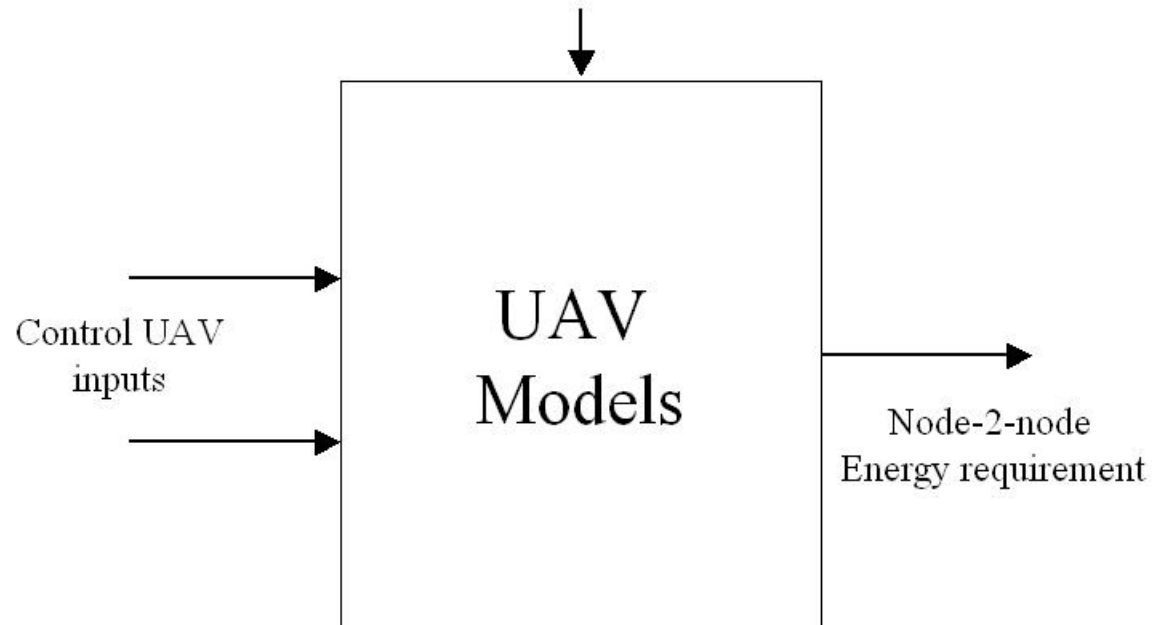
$$a_{ij} = \begin{cases} \mathbf{x}, & \text{if } (v_i, v_j) \in E \text{ and } \mathbf{x} \in \mathfrak{R}^{+*}; \\ 0, & \text{if } (v_i, v_j) \notin E. \end{cases}$$

$$\text{tr}\mathbf{A} = \sum_{i=1}^n a_{ii}$$

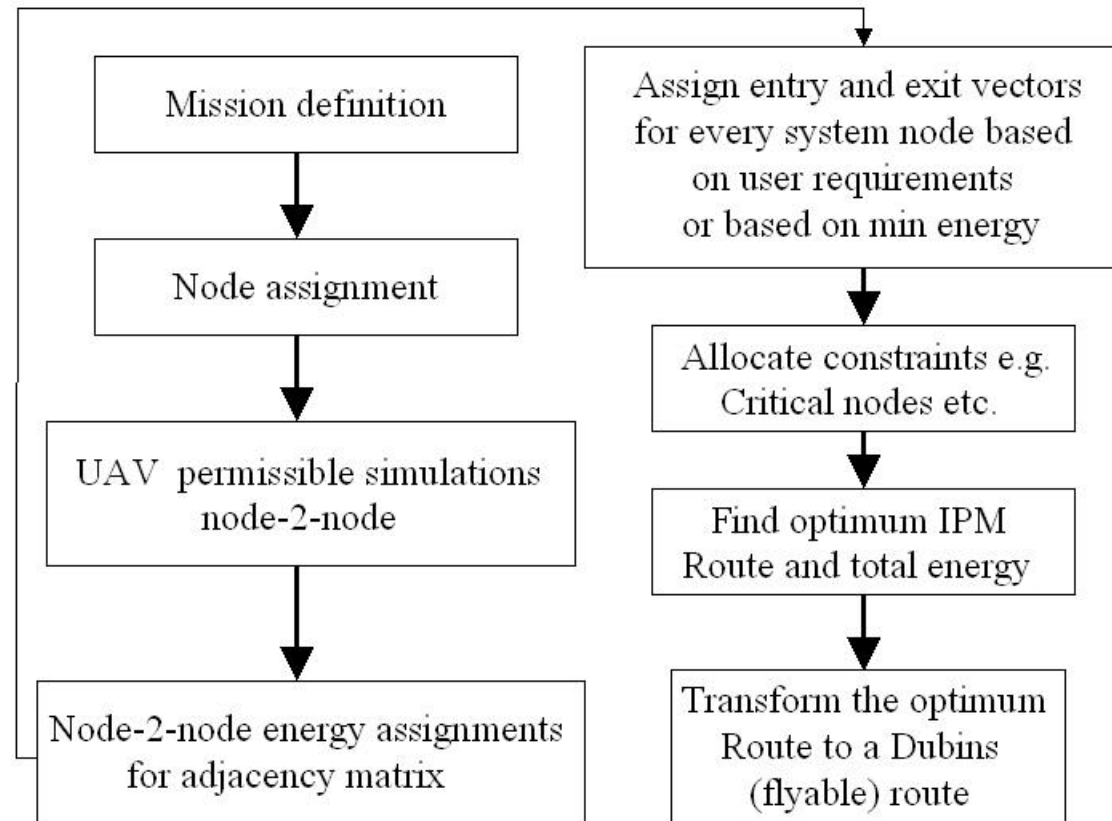


Mission and Energy Requirements

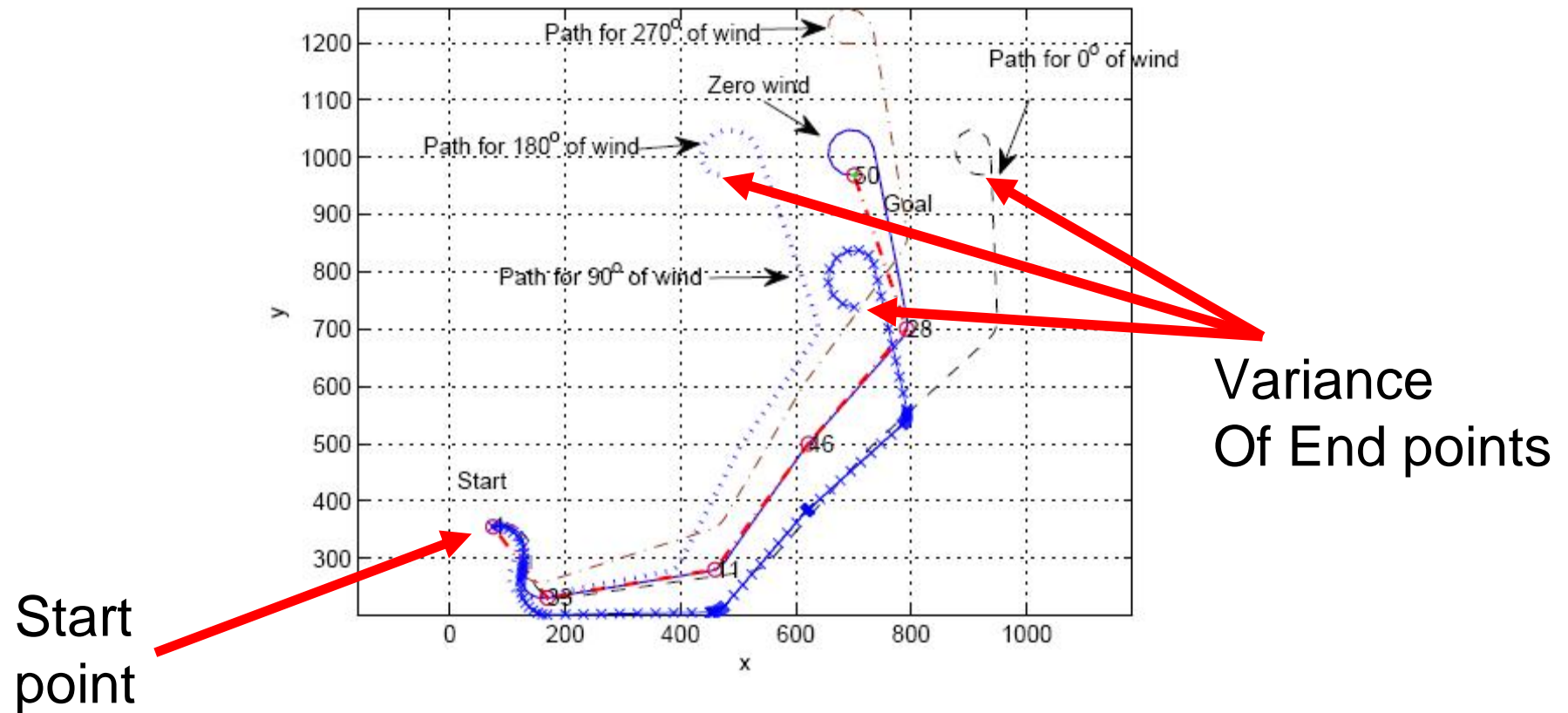
Exogenous wind phenomena which affect energy requirements



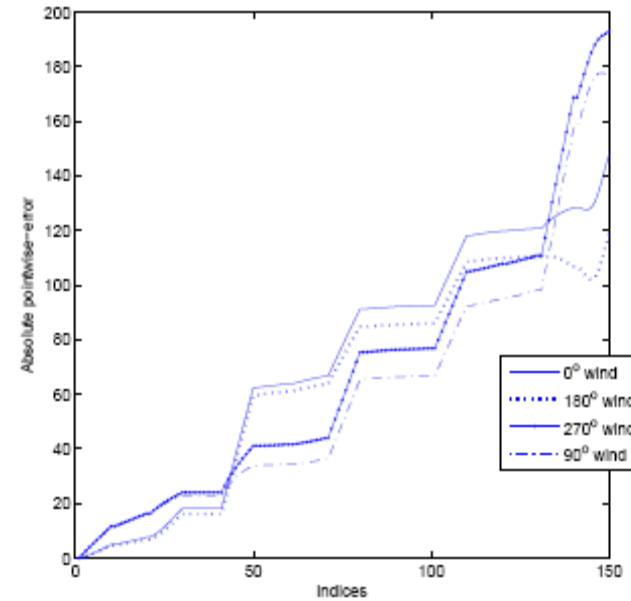
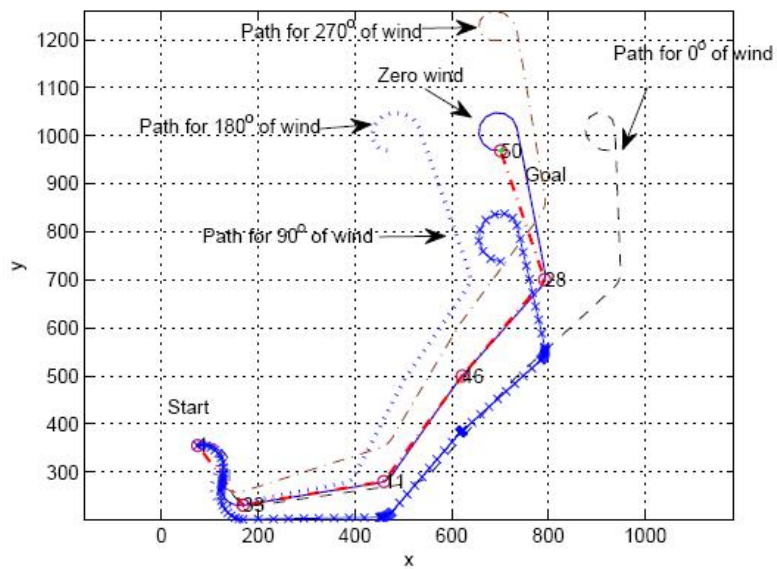
Flowchart of Fundamental Processes



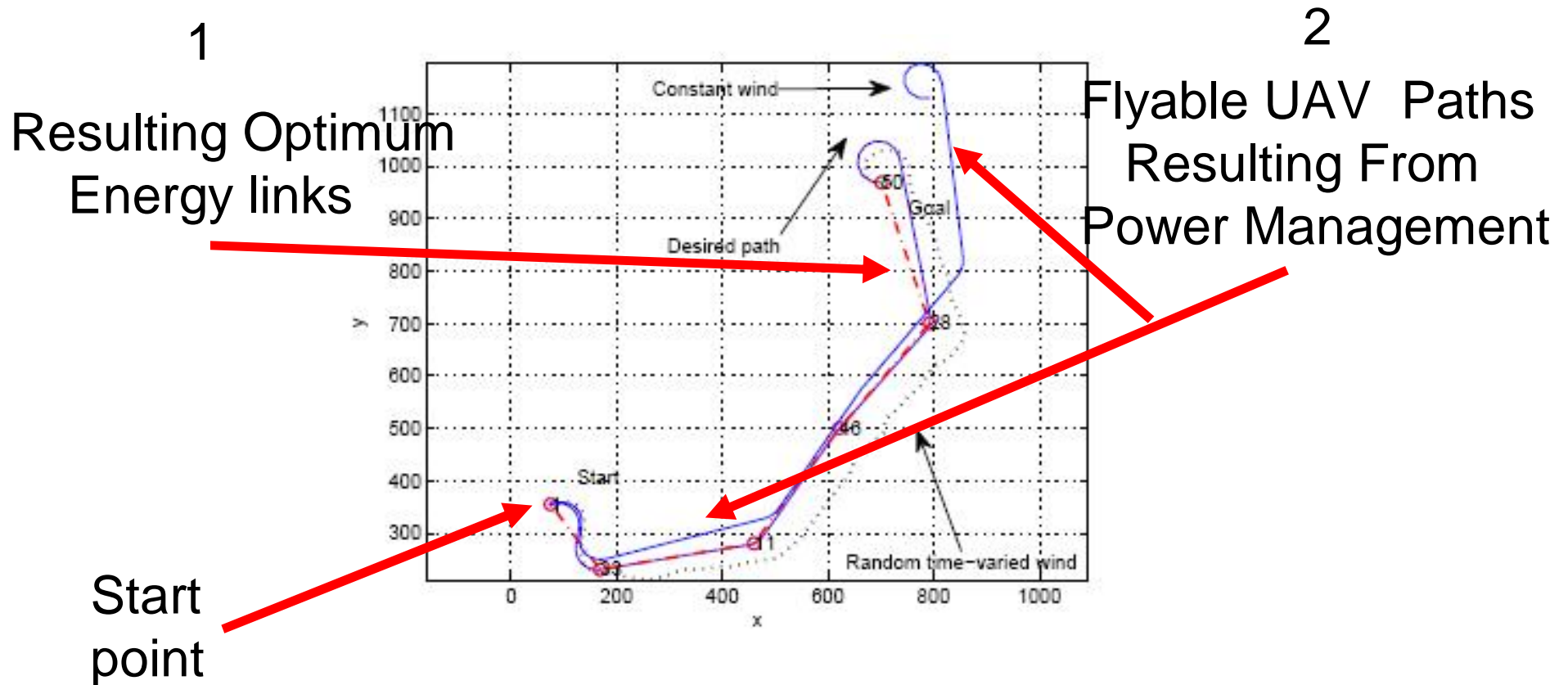
UAV Trajectory Results Constant Wind Directions



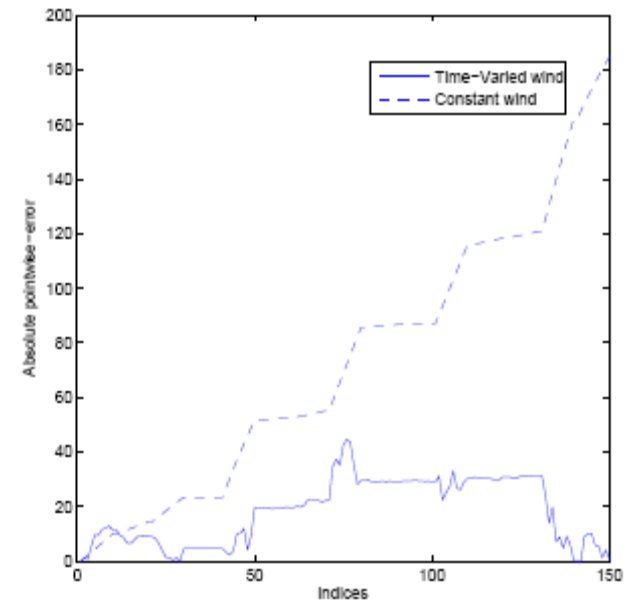
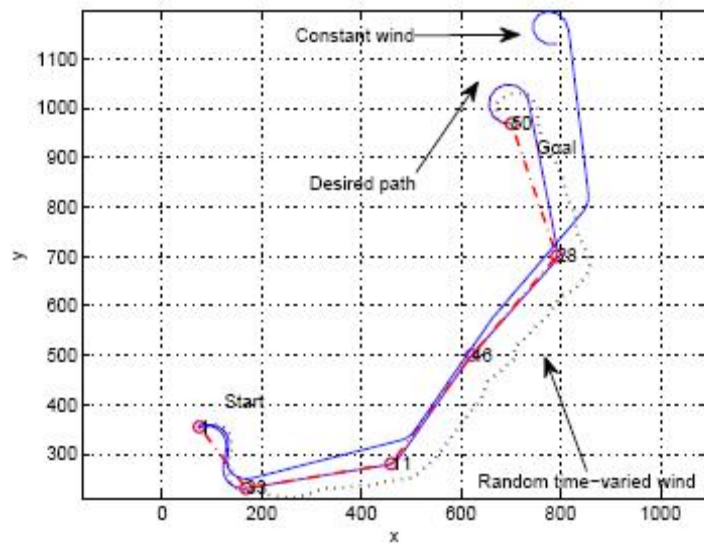
UAV Trajectory And Error



UAV Trajectory Results Random wind Directions



UAV Trajectory And Error



Concluding Remarks

The advantages for the proposed Intelligent Power Management (IPM) methodology are:

1. Reducing Operational Dependency on Fossil Fuels
2. Reducing fuel usage through innovative approaches to mission management
3. Potential to reduce significantly the vehicle mission economic costs.
4. Potential to simplify the refuelling logistics.