LAY-OUT OF AN LTA CARGO CARRIER FOR AUTONOMOUS UNMANNED OPERATION

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(1) Requirements and Constraints

(2) Selection of Viable System

(3) System Concept and Fleet Operation

(4) System Definition and Options

(5) First Steps for Realization

(6) Need for a Thorough Feasibility Study

Cargo transportation demands in off-road areas with the specific needs of mining, forestry, oil drilling and remote native communities in Northern Canada

Key Requirements:

- Acceptable economy of operation
- Ecology: minimum impact on environment
- Utilization of available technologies
- Feasibility of step-wise implementation

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Transportation Economy of Bulk Cargo:

- **Waterway** transportation provides the lowest cargo rates due to the high buoyancy of water and low fuel consumption

- **Railways** are an efficient system of transportation due to high possible capacity and relatively low energy requirement

- **Trucks** represent today the most flexible mode of transportation, although fuel requirement and personnel costs per ton of payload are higher than for the previously described systems

- **Air transportation** is expensive and requires adequate runways

- **Air transportation** into inaccessible unprepared places is confined to VTOL systems, i.e. helicopters and/or LTA systems

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Physical Constraints and Req'mts for Cargo VTOL Systems:

Limitation of ground pressure (footprint) in case of cargo helicopters, hybrid systems and/or LTA ground equipment

Limitations w.r.t. clear ground operations area especially for LTA (e.g. mooring circle)

Selection of carrier systems for oversize payloads as well as for quick loading / unloading procedures

Quick takeoff capability to evade foul weather conditions

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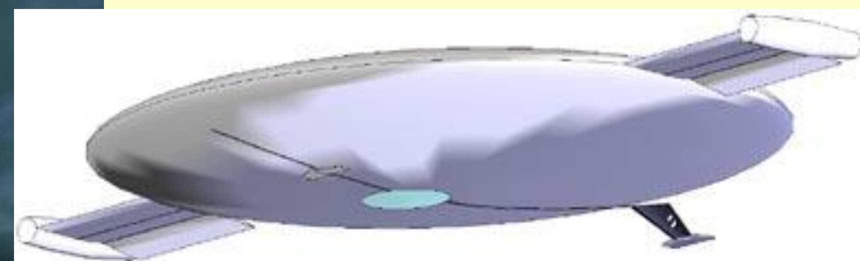
Candidate Hybrid VTOL Systems

Hybrid Skyhook



Lenticular Hybrid

AirFerry

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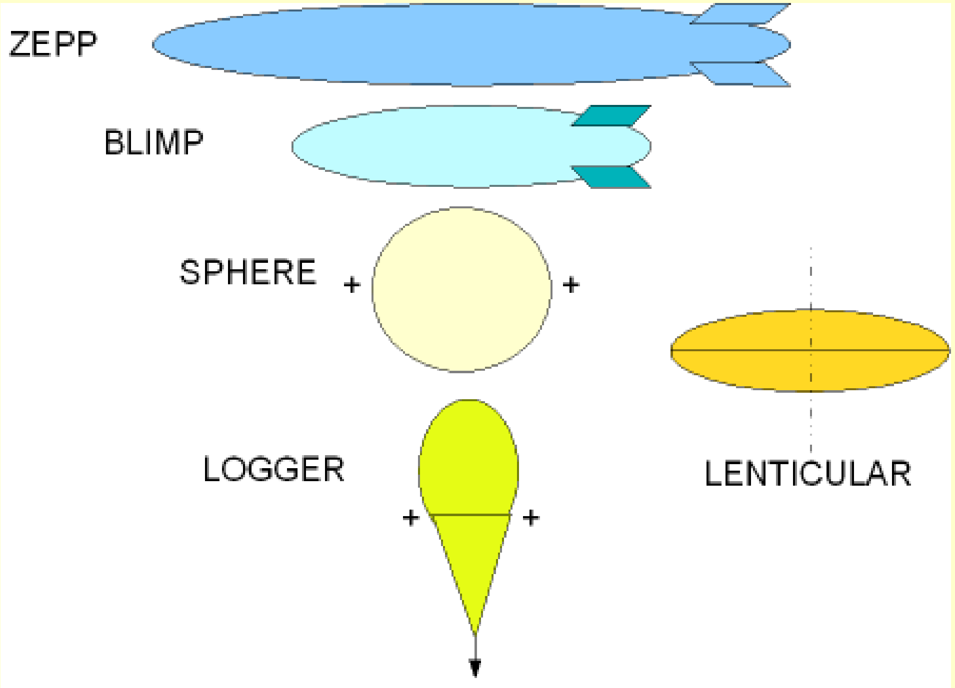
Selection of Candidate Buoyant LTA Systems :



Performance preferences:
ZEPP for long range, ... LOGGER for short range operation

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Dilemma of Airship Sizes for Outpost Ground Handling

- Large airships provide higher payload capacity for economical transportation, but ...

- require heavy ground handling machinery, mooring masts and clear weathervaning circles (e.g. Hindenburg about 500 meters diameter corresponding to 0,2 square kilometers), besides ...

- may be oversized for a multitude of missions

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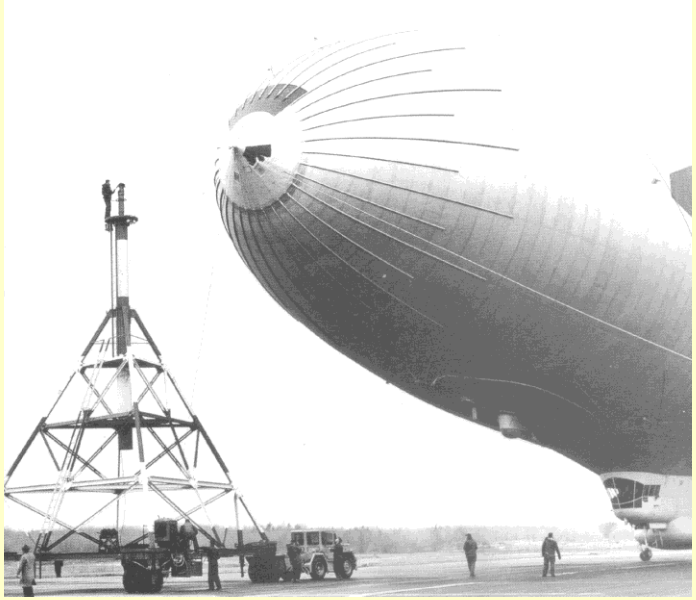

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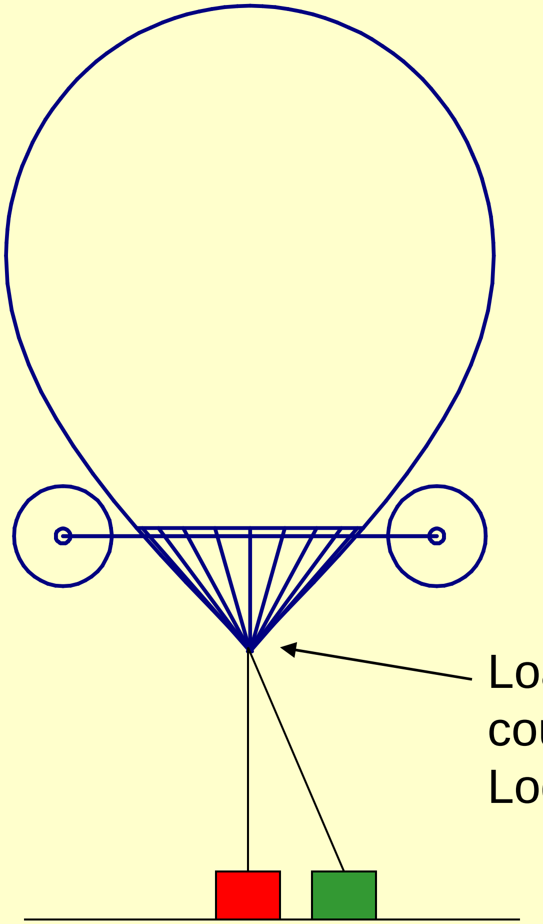
Darwin's Selection:

LTA-Logger Concept

Suspended Cargo Carrier



Cone accommodates equipment and instrumentation for autonomous and telecommanded operation, water ballast system and hoists

Load concentration cone accommodates coupling interface with ground anchor for Logger parking

Simplified quick load exchange system

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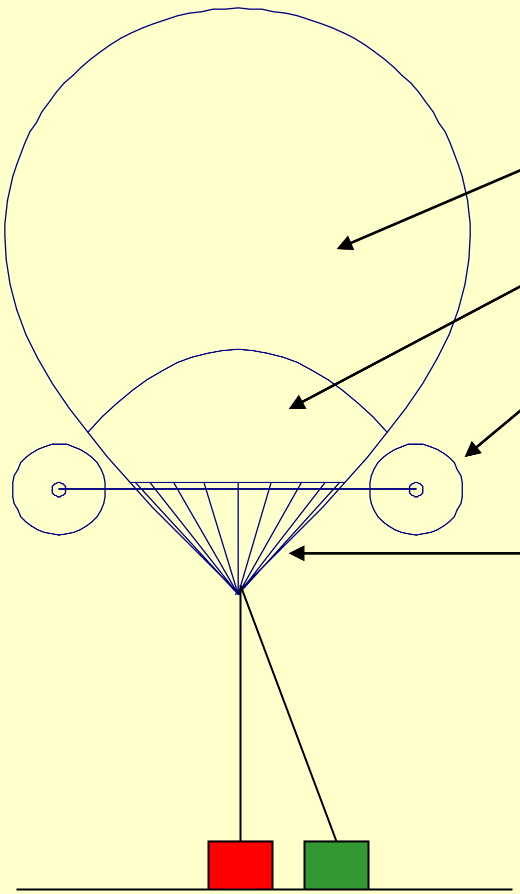
Suspended Cargo Carrier



30 m diameter about spherical aerostat

Ballonet flushed with inert exhaust gases

6 m diameter electrically driven propellers

Conical gondola designed as self-standing subassembly including:

- 2 APUs / generators
- fuel and lub tanks
- exhaust condenser + ballast water tank
- 2 hoists + ground anchor coupling
- avionics / sensorics / control systems

Hook-up load exchange system

Operational Requirements for Cargo Exchange

(1) Exchange of routine supplies, e.g. combustibles, food, spare parts. Return cargo e.g. lumber, minerals, unused equipment, refuse, ballast in the order of tons

(2) Exchange of higher quantities of apportionable goods, e.g. tools machinery, fuel, spare parts in return for e.g. lumber, ore, minerals etc. in the order of tons requires **fleet shuttle operation**

(3) Exchange of goods in the order of ten tons, e.g. lumber, ore, minerals requires increased shuttle frequency and/or increased carrier capacities, respectively

(4) Transfer of heavy cargo in the order of forty tons up, e.g. indivisible equipment (rigs, generators etc.) requires special high-capacity carrier systems

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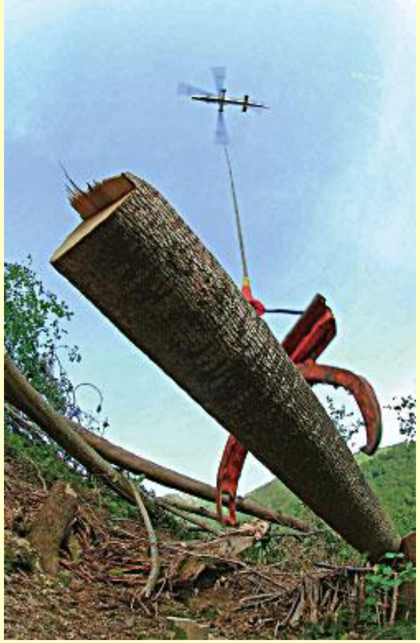
The LTA Logger is also suited for the transfer of lumber from inaccessible areas

Potential substitute for present day's helicopter logging operation:

- zero power at hover

- no downwash

- no noise



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Low Airspeed Operation

The ground speed of slow-flying LTA carriers may be strongly affected by the prevailing wind conditions

One turbine generator will provide power for an IAS in the order of 50 km/h which suffices for economic operation the case of short ranges at still air or tail wind

Two turbine generators are foreseen for IAS in the order of 70 km/h in the case of headwind or to evade foul weather conditions

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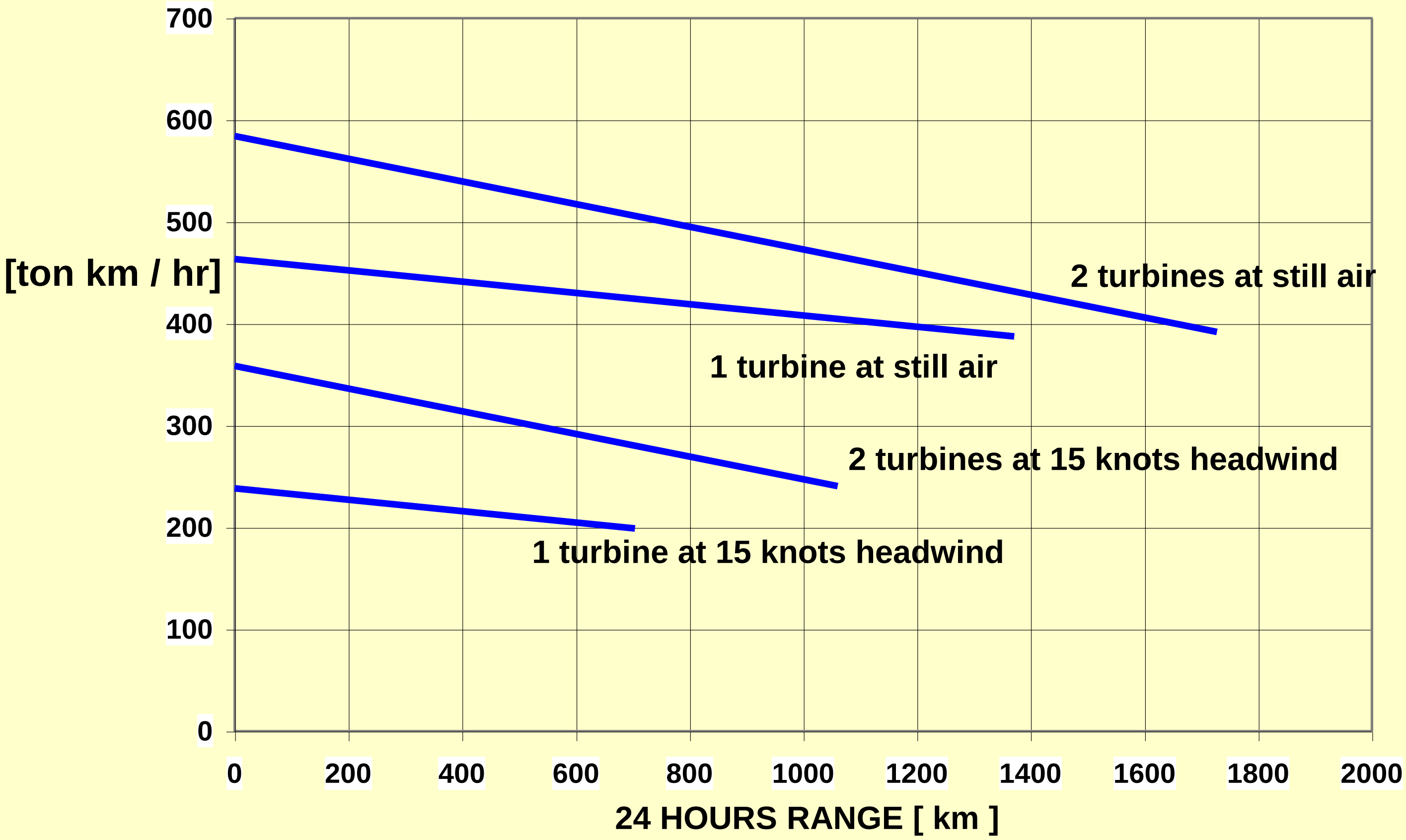
TRANSPORT EFFICIENCY



Advantages of Fleet Operation

Fleet operation requires serial production of carriers with corresponding reduction of cost per item

Flexibility w.r.t. adapting to respective mission volumes

Redundancy in case of carrier failure/downtime

Potential availability over wide areas

No dead time during step-wise future modernization

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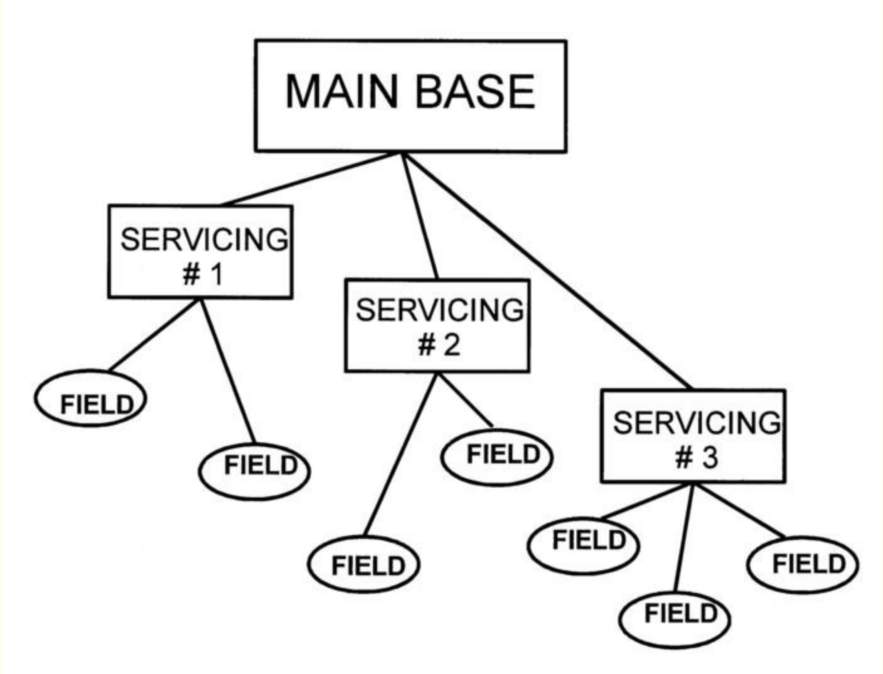
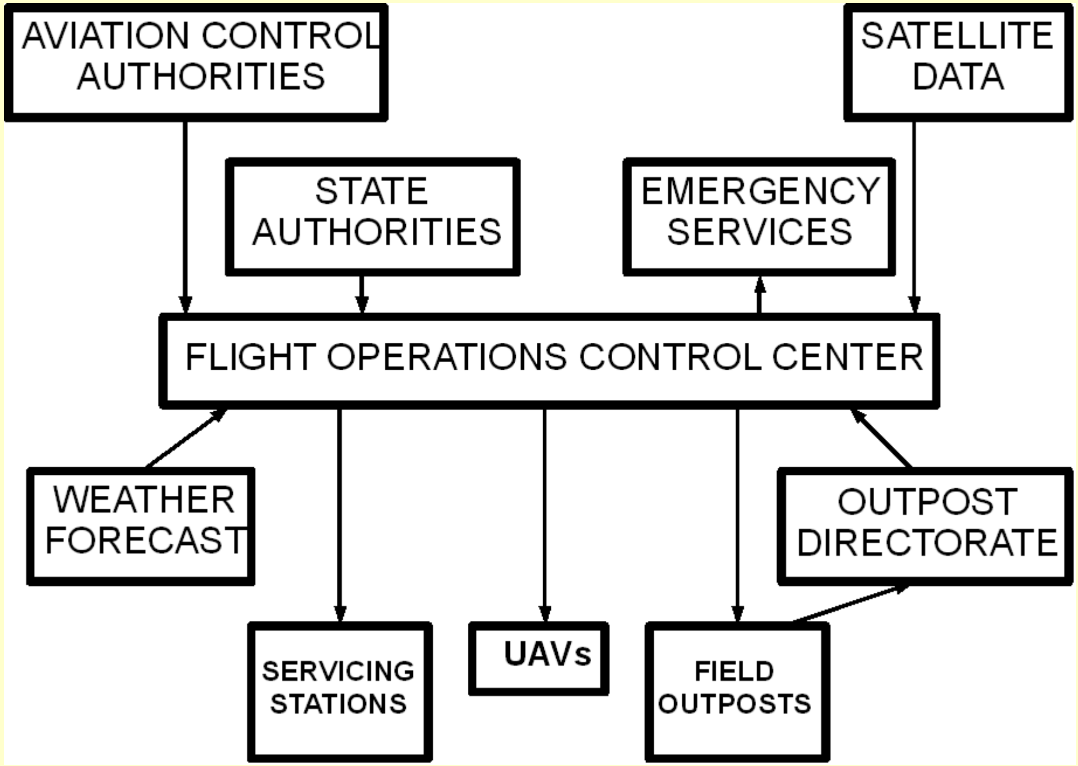
Fleet Operation Requires a Logistic Hierarchy



Servicing stations are to be located at a road, railroad and/or navigable river or canal closely at medium distance from the field outpost(s) for efficient cargo transfer.

Servicing stations shall provide storage facilities for liquid methane, pressurized hydrogen and inter-mediate storage for payloads to be shuttled to/from outpost field stations.

Mandatory Flight Operations Center for UAVs



The Flight Operations Center provides coordination, monitoring and control of all systems of the UAVs as well as weather forecast, com-puterized strategies and emergency operations

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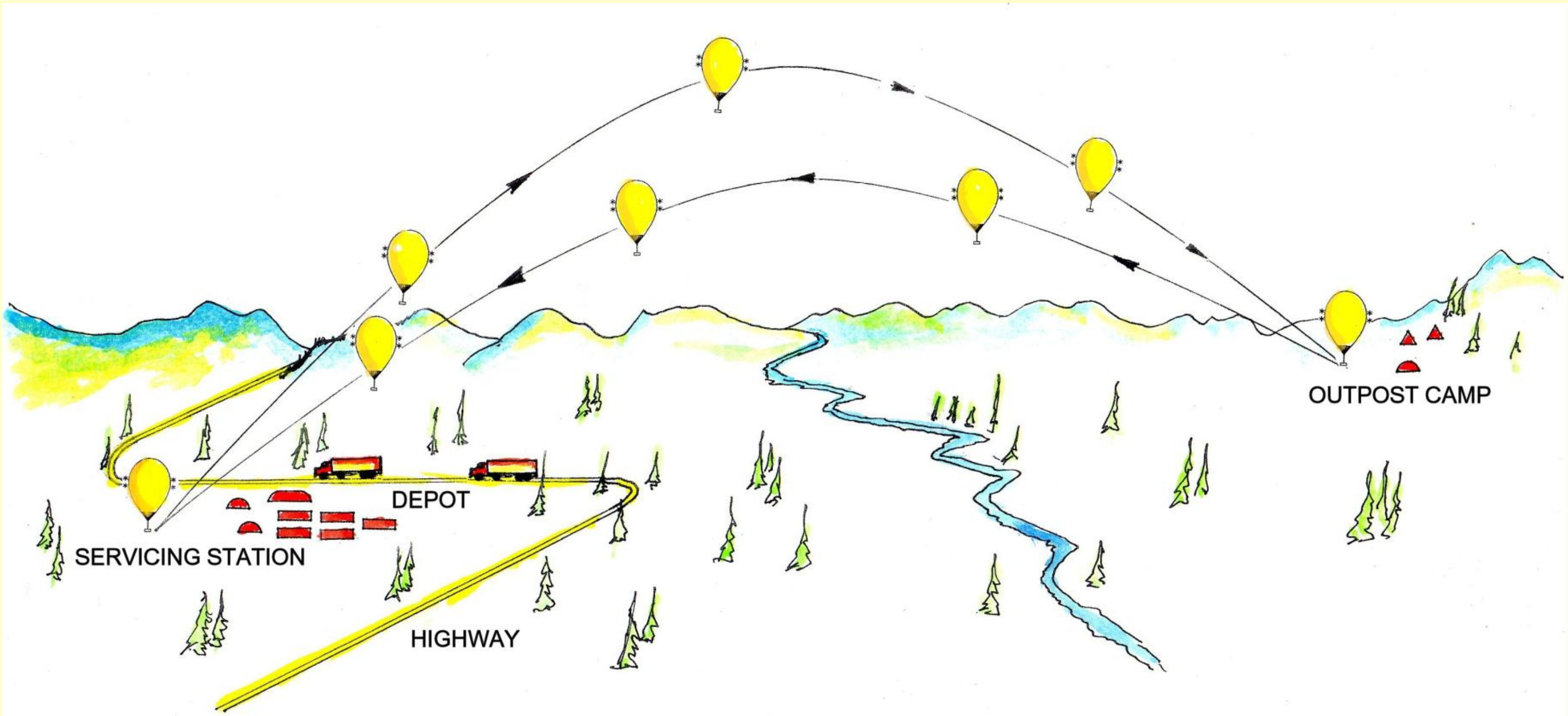

Scenario of a transportation chain for apportionable goods

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Selection of Ecological and Economic Fuel

Liquefied hydrogen:

- provides the highest energy content per kg
- produces no carbon dioxide, yet
- is not practical for usage in field operations

Natural Gas / Methane:

- lowest carbon dioxide per kilowatt
- easily liquefied
- generally available at a low price level

Gaseous hydrogen:

- low priced
- highest lifting power
- flammable, hence optional energy carrier
- at any rate acceptable for unmanned operation

Selection of Ecological and Economic Fuel

Aerostatic Lift Control to compensate the weight loss of used liquid fuel, collect ballast from exhaust condenser, or

add an equivalent hydrogen lifting gas as fuel gas to reduce the aerostatic lift accordingly.

Fuel switch for altitude trim:
- use LPG without condenser for climbing
- use hydrogen for descent

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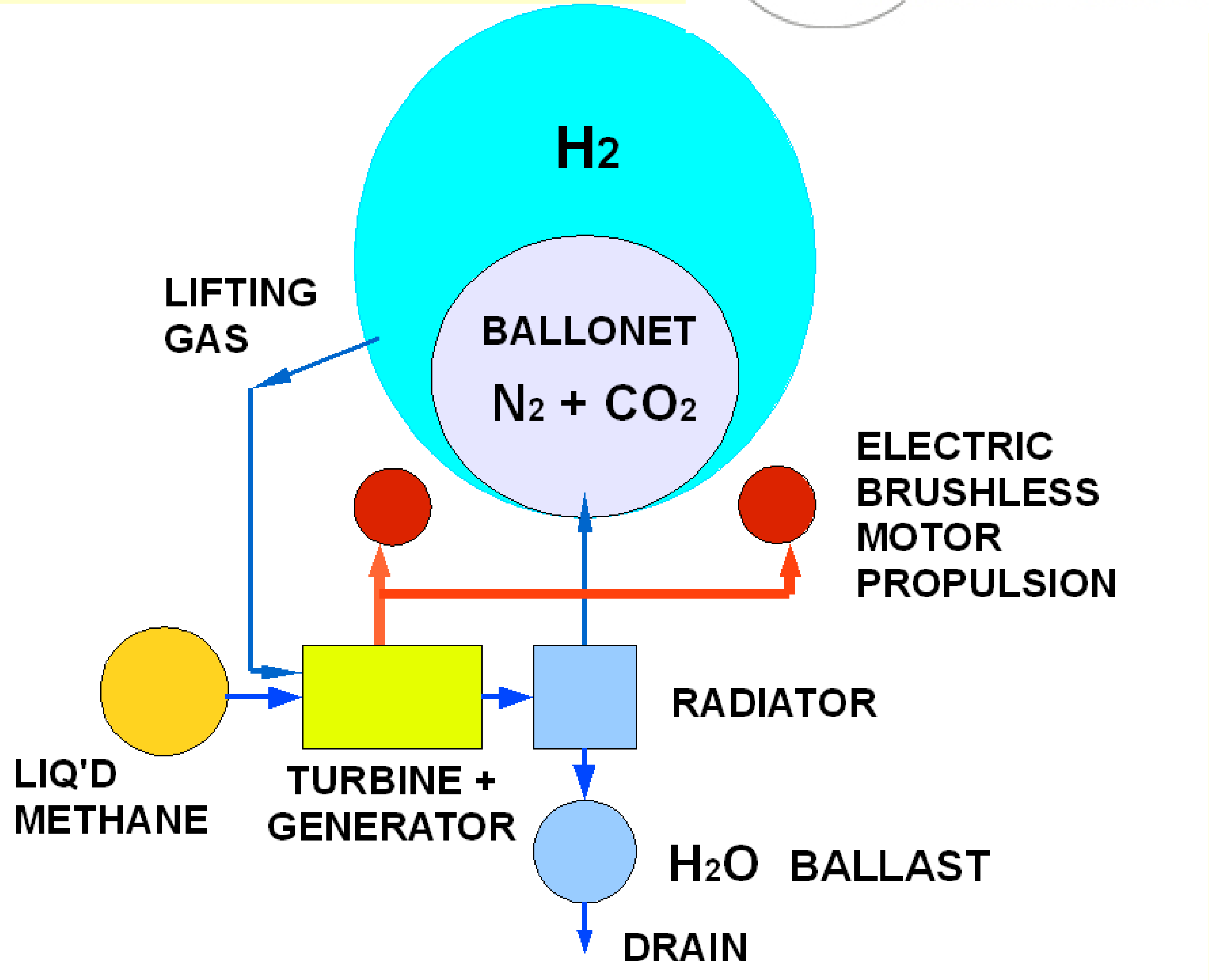
H2
BALLONET
N2 + CO2
LIFTING
GAS
ELECTRIC
BRUSHLESS
MOTOR
PROPULSION
RADIATOR
LIQ'D
METHANE
TURBINE +
GENERATOR
H2O BALLAST
DRAIN

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Rationale for Fleet Build-Up

Assumption:

A great number of missions could be performed by LTA carriers having a payload capacity in the order of tons

Fleet Operation:

Transportation of apportionable payloads could be distributed over a shuttle fleet within a logistic network

Heavy Cargo:

Heavy and indivisible payload requires few large-size LTA carriers for payloads up to about 40 tons and more

Prerequisites for a Fleet Build-Up:

- o Market analyses to define smallest generally usable size
- o Intermediate test model for helium operation
- o Test prototype: e.g. lumber, minerals, servicing settlements
- o Qualify for serial production and fleet operation

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Key Issues of a Feasibility Study

System Definition and Verification:

Parametric optimization w.r.t. sizing, environmental and operational assumptions, power and fuel requirements

Fleet Operations Analysis:

Flight economy optimization and adoption of key findings of available market analyses and and their impact on fleet operation requirements

Selection, Manufacturing and Integration of Hardware:

Identification of potential suppliers and manufacturers.
Establishment of a project team

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Key Issues of a Feasibility Study (cont’d)

Preliminary Project Time Table:

- o Milestone chart
- o Design review cycles
- o Cost estimates
- o Manufacturing
- o Integration and Test
- o Certification plan

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Thanks for your attention!
Questions ?