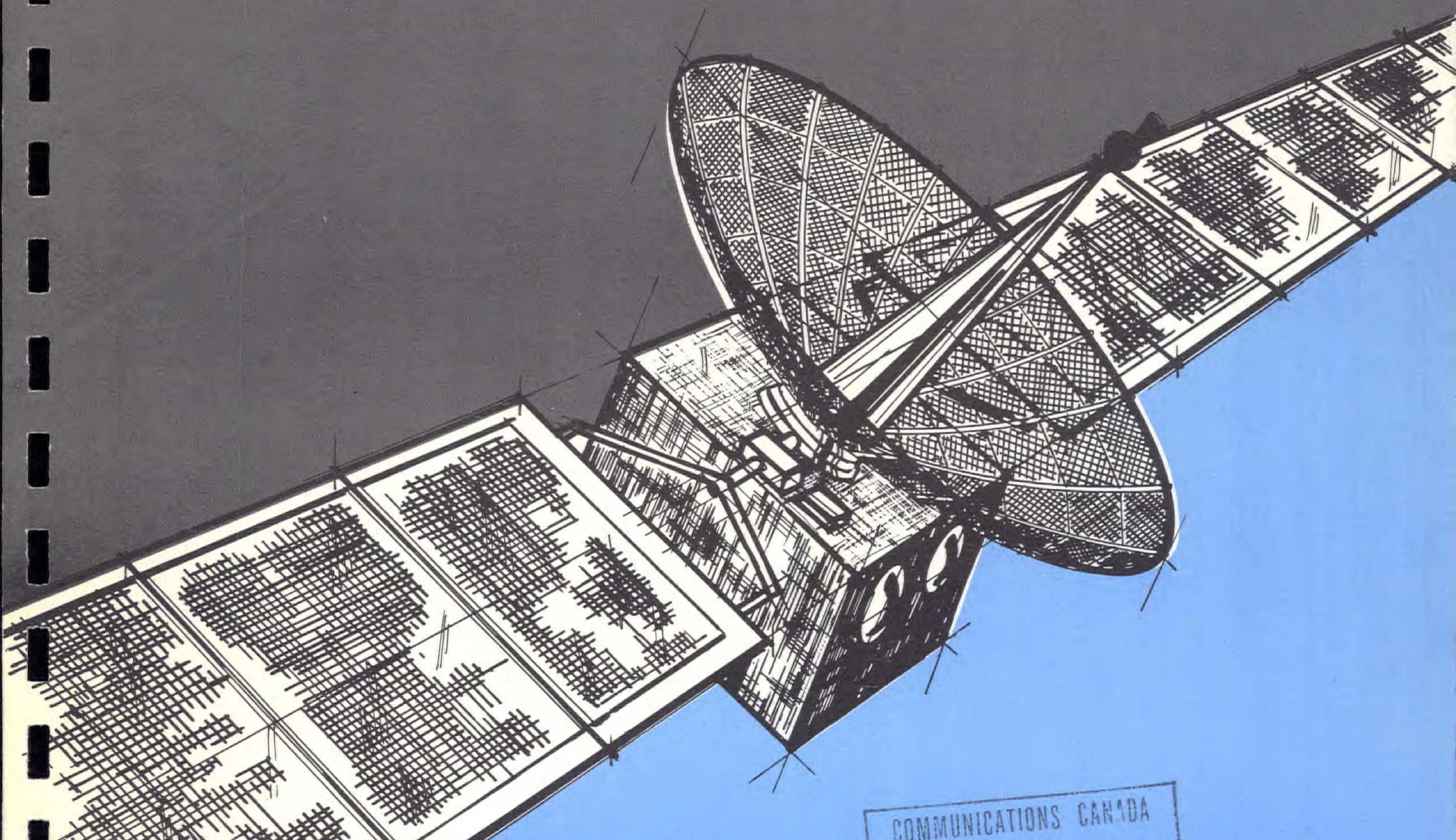


EXECUTIVE SUMMARY
GENERAL PURPOSE SPACECRAFT BUS

executive summary

ABSTRACT OF SPAR REPORT R. 677
FEASIBILITY STUDY OF A GENERAL PURPOSE SPACECRAFT BUS

PREPARED FOR DEPARTMENT OF COMMUNICATIONS

REF: DEPARTMENT OF SUPPLY & SERVICES CONTRACT

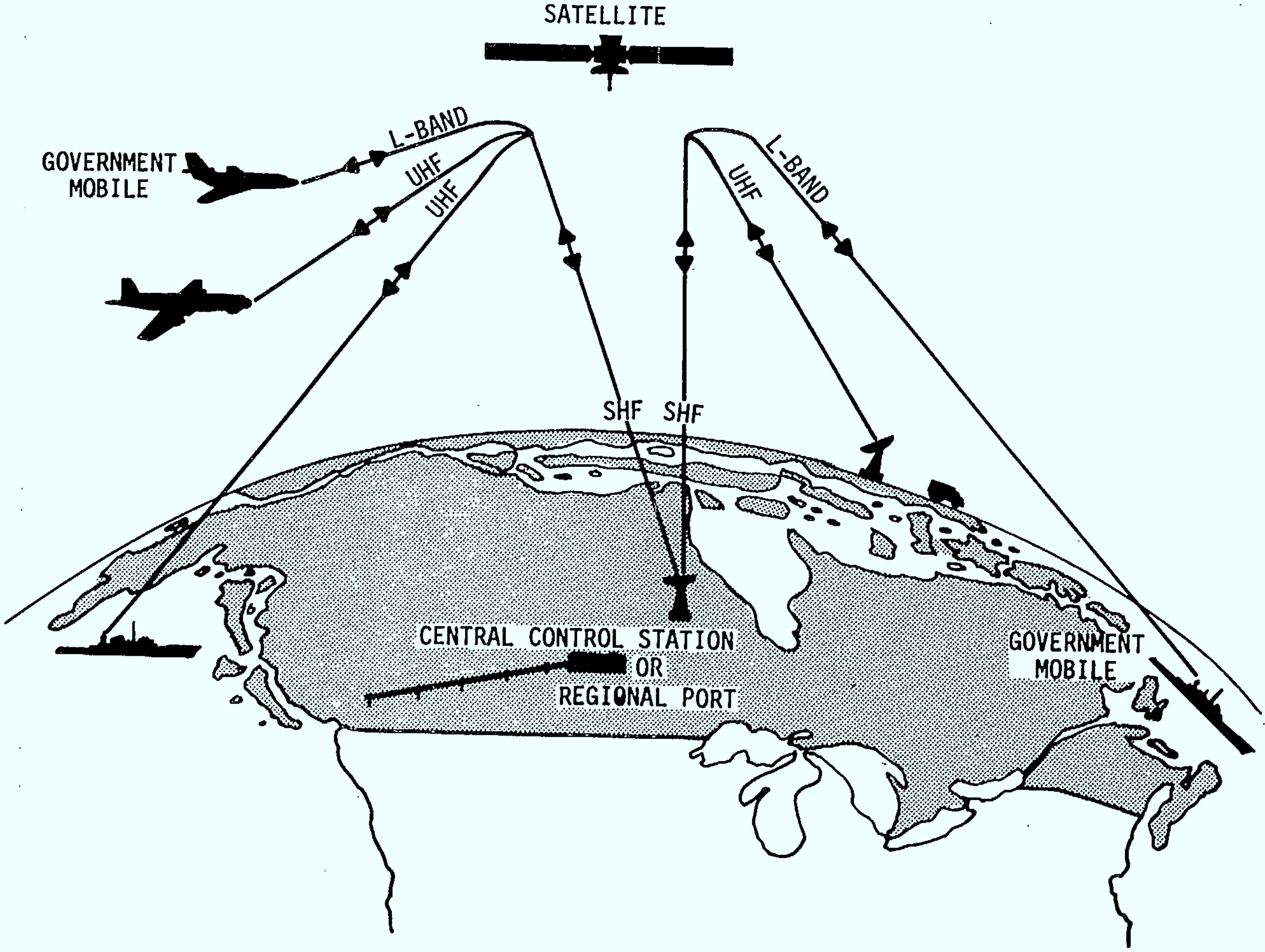
PL 36100-4-2010
SERIAL NO. OPL 4-0192

JULY, 1975

THE GENERAL PURPOSE BUS
GPB

A STANDARD SERVICE MODULE TO PROVIDE A COST-EFFECTIVE SOLUTION TO THE NEXT GENERATION OF GEOSYNCHRONOUS ORBIT CANADIAN SATELLITES

COMMUNICATIONS SYSTEM CONCEPT



SPAR

REQUIREMENT

A GENERAL PURPOSE SPACECRAFT BUS FOR THE NEXT GENERATION OF CANADIAN COMMUNICATIONS SYSTEMS.

A number of communications networks are in the planning stages for military, civilian and commercial applications. A modular spacecraft bus capable of carrying any one or combinations of the projected payloads is the most cost-effective means of providing the space segment for these systems.

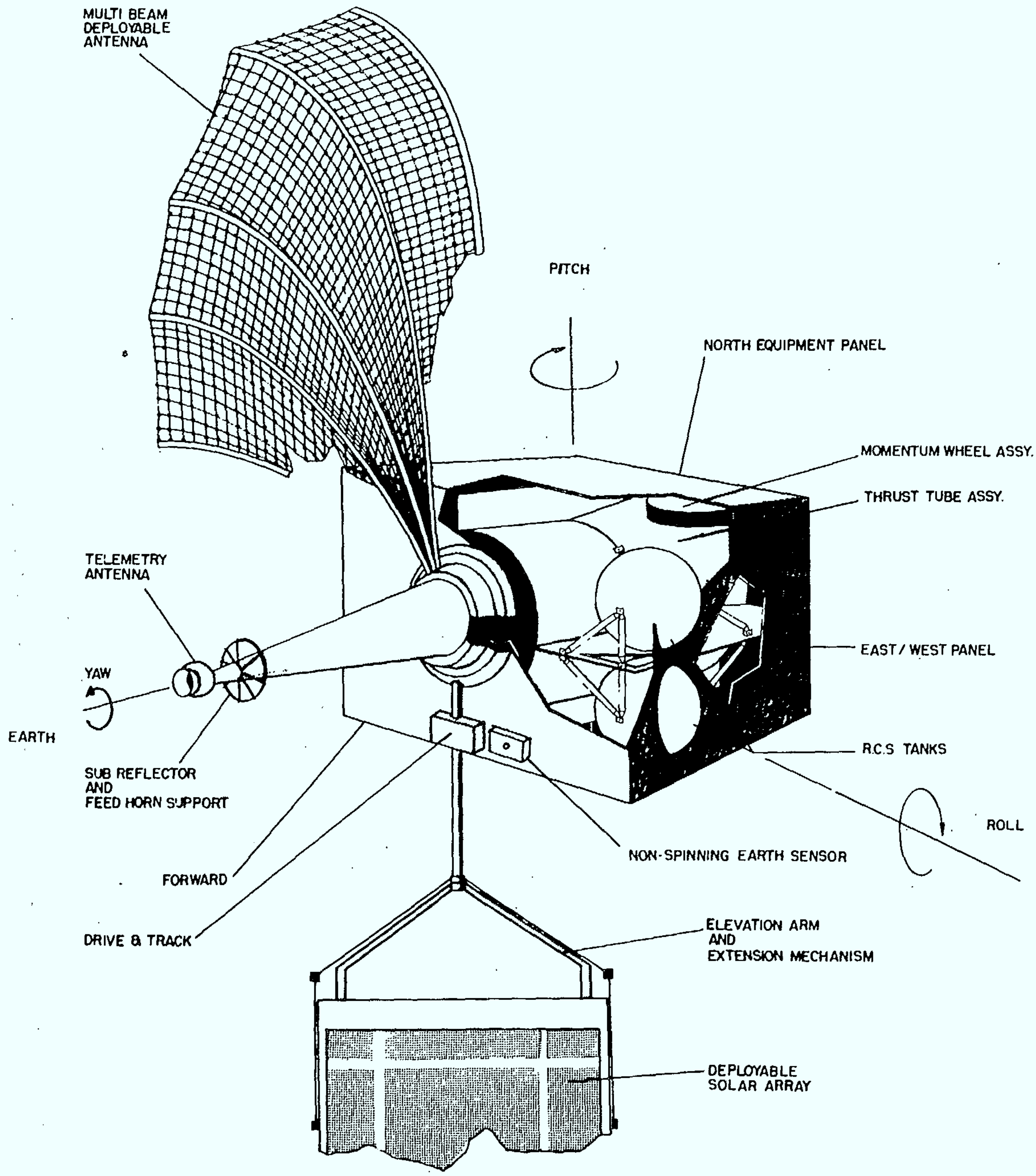
Studies by the Department of Communications have identified at least five different possible configurations of communications equipment and experiments which will allow the space portion to satisfy a variety of expected requirements. Four of these are directed at a mixed UHF and SHF system for military and civilian communications. These payload options with weight and power requirements are given below and include options for L-band navigation and scientific experiments.

(a)	UHF plus 12-channels 4-6 GHz,	Weight 218.4 lb,	Power 414.9 watts.
(b)	UHF plus 4-channels 12-14 GHz,	Weight 180.5 lb,	Power 624.6 watts.
(c)	UHF plus 7-8 GHz plus experiments,	Weight 221.9 lb,	Power 505.2 watts.
(d)	UHF plus 7-8 GHz plus L-band,	Weight 190.4 lb,	Power 513.2 watts.
(e)	24-channel 4-6 GHz,	Weight 231 lb,	Power 400 watts.

Not listed in the requirements are those payloads which were identified by Telesat late in the study, but which can likely be incorporated within the present baseline design.

Since present generation Canadian spacecraft cannot accommodate these payloads, a new spacecraft is required which can be easily adapted for the payloads envisaged for the next decade, or until the Space Shuttle launch platform is available. Three to eight spacecraft may be required, each possibly with a different payload combination. This spacecraft will be designed for launch on a Thor Delta 3914 vehicle and will be compatible with existing ground station equipment, placing stringent requirements on orbit control ($\pm$ 0.05° N/S and E/W) and pointing ($\pm$ 0.15° N/S and E/W). A six to eight year service life is required with a minimum investment in ground facilities devoted to spacecraft operational maintenance.

G.P.B. CONFIGURATION



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THE GENERAL PURPOSE BUS

A GENERAL PURPOSE BUS (GPB) WHICH MEETS THE SPACECRAFT REQUIREMENTS IS FEASIBLE AND CAN BE BUILT IN CANADA.

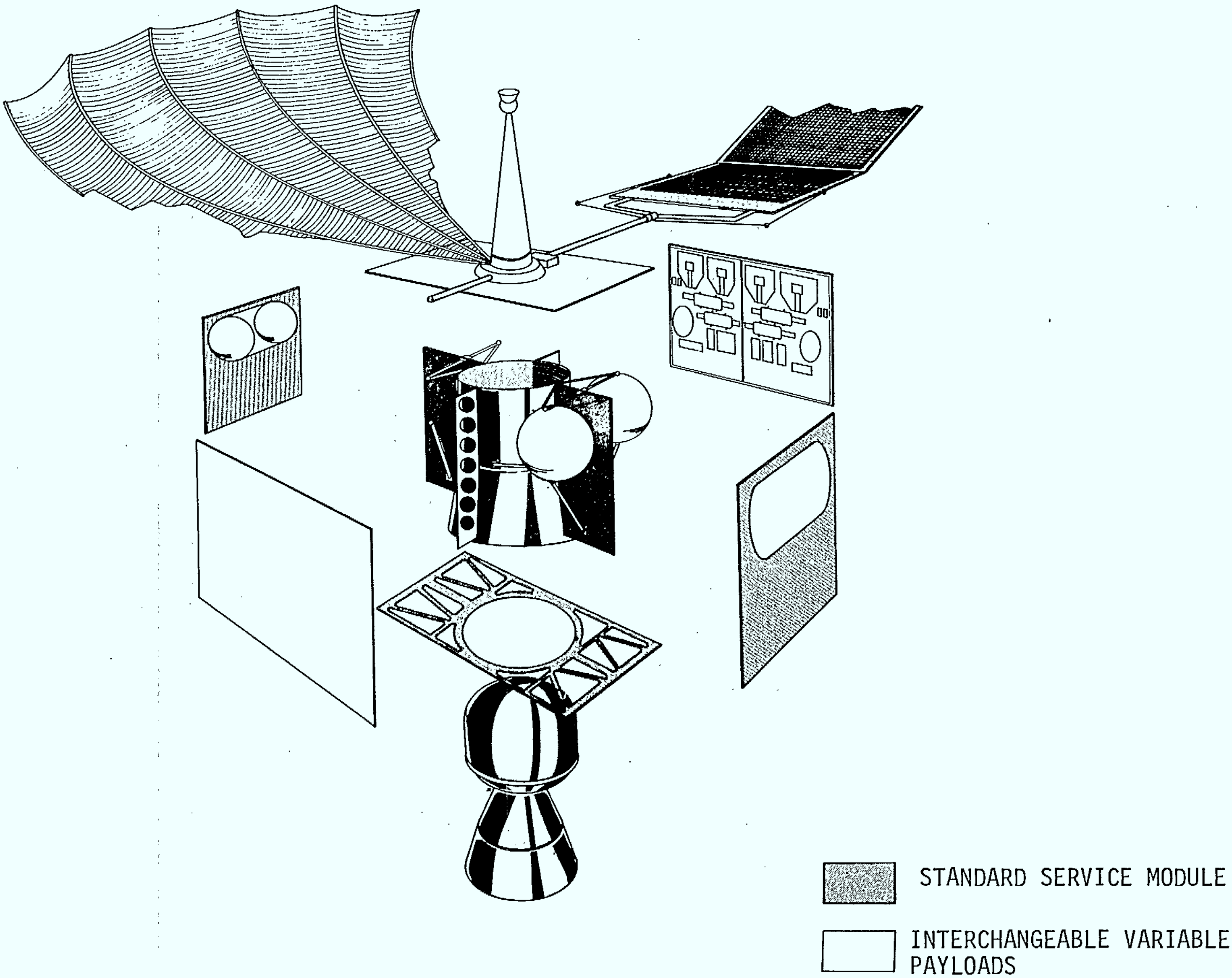
A baseline GPB configuration has been selected that:

- Employs a modular concept to accommodate all identified payload options.
- Utilizes advanced performance attitude control, reaction control and deployable solar array subsystems.
- Meets all design and performance requirements.
- Can be further developed to provide increased payload capability.

Major system parameters of the bus are:

- Launch vehicle:	Thor Delta 3914
- Design Lift-off Weight Capability:	1925 lbs (excluding adapter)
- Lifetime:	Six years (RCS fuel) Eight years (RCS tanks and solar array)
- Max. Array Power:	1160 watts Beginning of Life
- Min. Array Power:	835 watts End of Life 94 Watts Spin Phase
- Battery Power:	560 Watts (longest eclipse)
- Payload Carrying Capacity:	222 lbs
- Payload Power Available:	625 Watts EOL 465 Watts Eclipse
- Spacecraft Pointing Accuracy:	$\pm 0.15^{0}$ Roll and Pitch $\pm 1.0^{0}$ Yaw
- Stationkeeping Accuracy:	$\pm 0.05^{0}$ N/S and E/W

GENERAL PURPOSE BUS
(EXPLODED VIEW)



ADVANCED FEATURES

THROUGH THE USE OF LOW-RISK BUT ADVANCED TECHNOLOGY, THE GENERAL PURPOSE BUS WILL REMAIN CURRENT FOR THE NEXT DECADE.

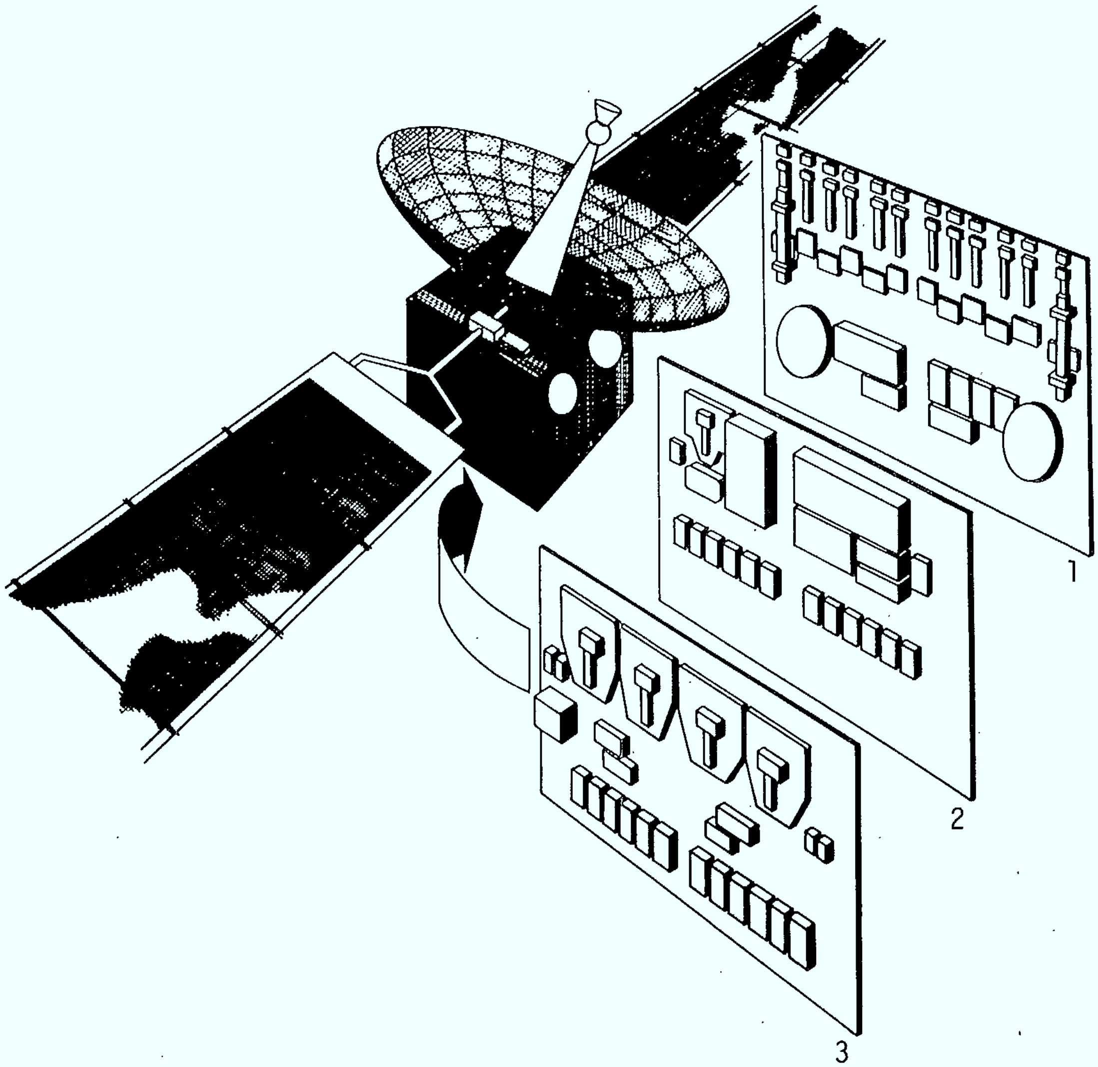
The GPB is competitive through to the era of Shuttle launches. The selected configuration of the baseline GPB has recognized the current state of development of space technology and has incorporated those advances which are in the process of development and are anticipated to be available within the expected timeframe of the GPB; in addition, without undue compromise to the baseline configuration, it has allowed for incorporation of various other developments which may reach completion during the GPB launch era.

Advanced features of the baseline GPB include:

- A hybrid attitude control system consisting of
  - single pitch magnetic bearing reaction wheel,
  - thruster control about roll and yaw,
  - microwave attitude sensing system.
- A reaction control subsystem employing low thrust electrothermal hydrazine engines with super heat.
- A deployable rigid substrate solar array utilizing high efficiency solar cells.

PAYLOAD VERSATILITY

1 12 CHANNEL 4-6 GHZ PANEL
2 UHF EQUIPMENT PANEL
3 4 CHANNEL 12-14 GHZ PANEL



PAYLOAD VERSATILITY AND DESIGN FEATURES

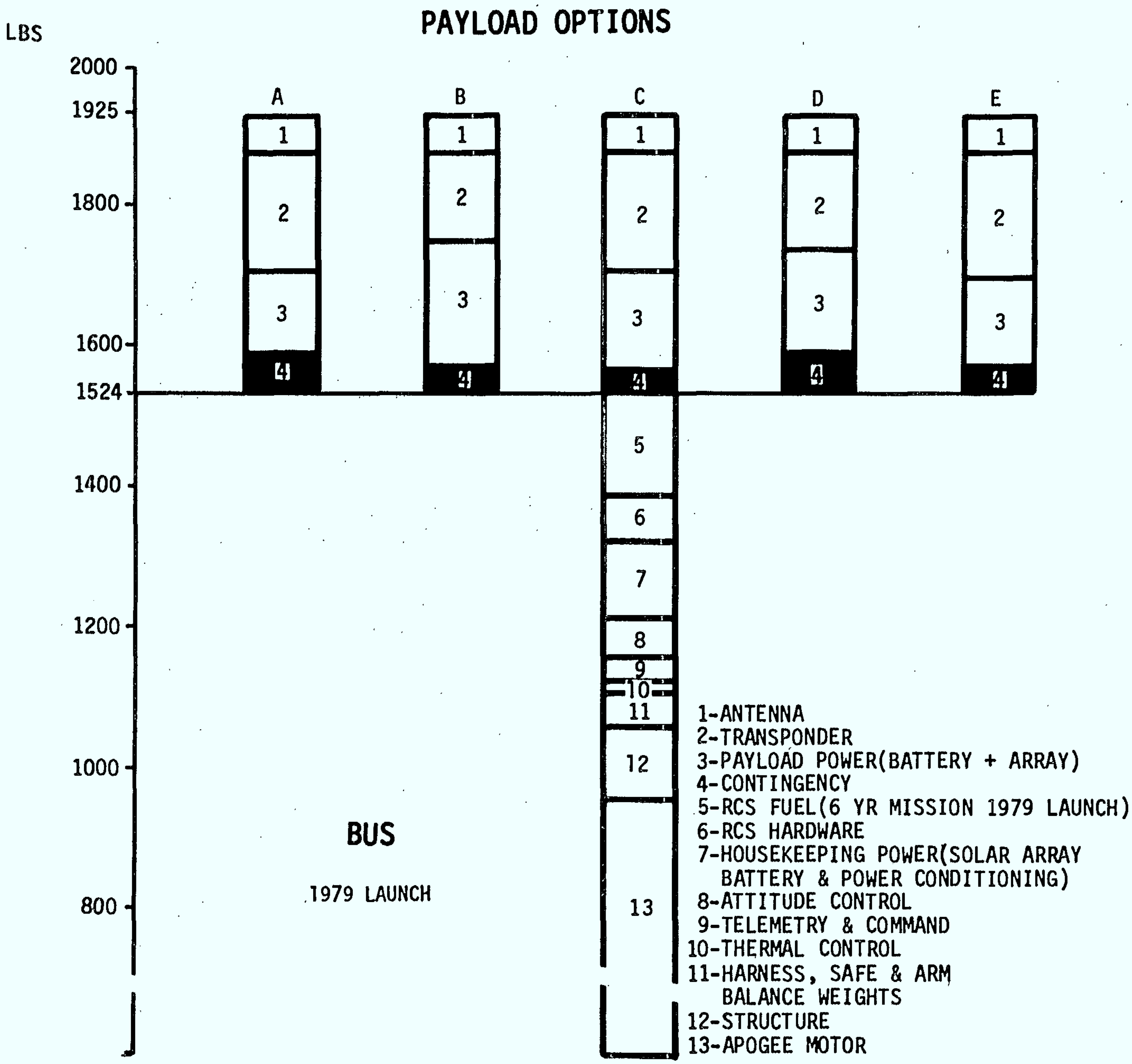
THROUGH MODULAR DESIGN, PAYLOADS ARE INTERCHANGEABLE.

The modular design concept of the bus permits accommodation (with efficient mass balancing by adjustment of designated housekeeping components) of a variety of payloads on the north, south and forward equipment platforms, with virtually no modification to the bus.

Principal features of the design are:

- A three-axis stabilized spacecraft for the multi-beam communications antenna and the TT&C bicone antenna mounted on the earth facing forward platform (perpendicular to the yaw axis).
- Communications transponders mounted on the north and south facing panels (perpendicular to the pitch axis) to minimize solar thermal effects.
- Deployable solar arrays stowed on the north and south platforms during spin phase, with portions of the arrays providing power for this phase of the mission.
- Apogee motor carried within a thin wall central thrust structure.

G.P.B.-PAYLOAD-WEIGHT EFFICIENCY



GPB: PAYLOAD-WEIGHT EFFICIENCY

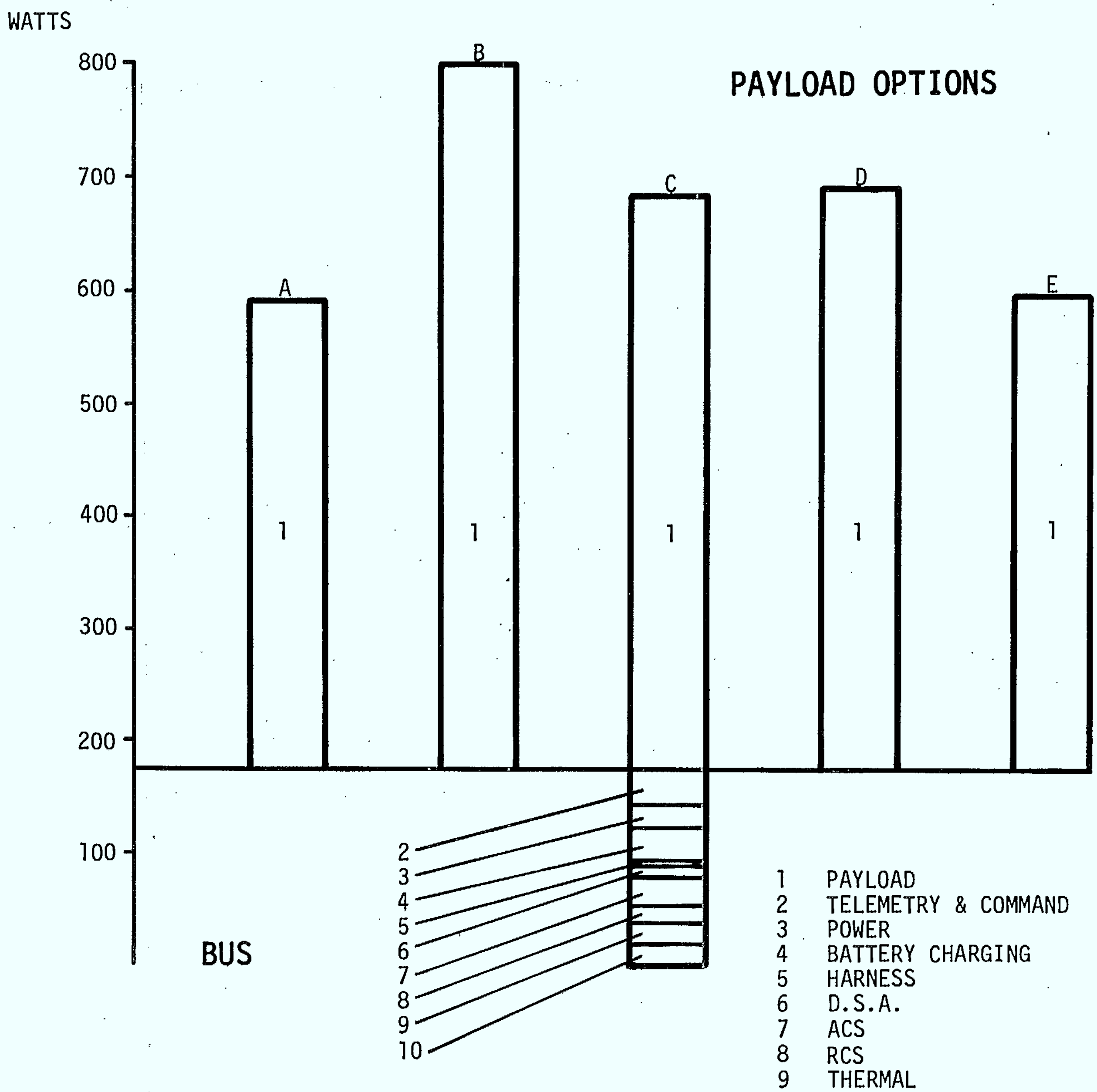
PAYLOAD OPTIONS (A) THROUGH (E) CAN BE ACCOMMODATED WITH WEIGHT MARGIN.

Through light-weight design features and incorporation of advanced technology, particularly in the attitude control, reaction control and deployable solar array subsystems, the GPB provides a weight efficient spacecraft bus for the next decade of Canadian geostationary missions.

Additional weight savings facilitating higher payload capacity can be gained by :

- further design optimization,
- incorporation of further technological developments which will maintain the GPB weight competitive at least until the era of Shuttle launches.

G.P.B.-PAYLOAD-POWER EFFICIENCY



GPB: PAYLOAD-POWER EFFICIENCY

POWER REQUIREMENTS OF THE FIVE PAYLOAD OPTIONS CAN BE MET, WITH CONSIDERABLE GROWTH ALLOWANCE.

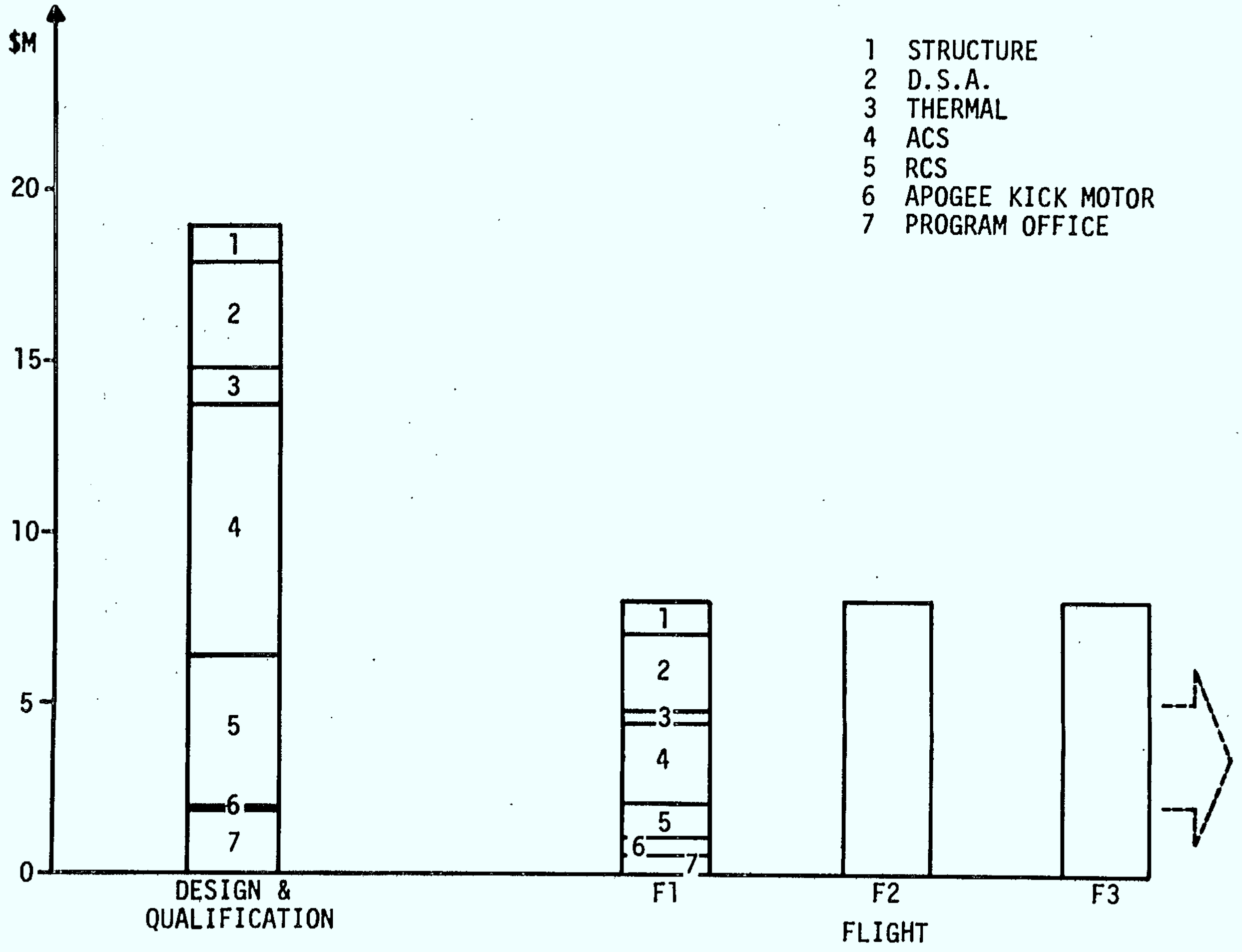
The deployable solar array subsystem features a light-weight rigid substrate array with high efficiency solar cells, capable of meeting existing payload power requirements for an eight year mission. The modular design of the DSA permits removal or addition of one panel per side giving discrete spacecraft power levels and hence power/weight optimization capability.

Incorporation of advanced design features presently in development, together with further detailed design optimization, provides a capability for considerable growth in power availability.

The five payload options mentioned previously are:

A.	UHF plus 12-channels 4-6 GHz,	Power 414.9 watts.
B.	UHF plus 4-channels 12-14 GHz,	Power 624.6 watts.
C.	UHF plus 7-8 GHz plus experiments,	Power 505.2 watts.
D.	UHF plus 7-8 GHz plus L-band,	Power 513.2 watts.
E.	24-channel 4-6 GHz,	Power 400 watts.

G.P.B. COSTS



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2 D.S.A.
3 THERMAL
4 ACS
5 RCS
6 APOGEE KICK MOTOR
7 PROGRAM OFFICE
DESIGN &
QUALIFICATION
F1
F2
F3
FLIGHT

GPB: COST EFFECTIVENESS

CONSIDERABLE ECONOMIC ADVANTAGES CAN BE ACHIEVED BY A SPACECRAFT BUS DESIGNED TO CATER FOR A MULTITUDE OF DIFFERENT PAYLOADS WITH FEW MODIFICATIONS TO ITS HOUSEKEEPING SUBSYSTEMS.

Through its modular design concept, the GPB provides a cost effective means of operating satellites that have the same general mission parameters such as orbit and launch vehicle and have similar weight and power requirements.

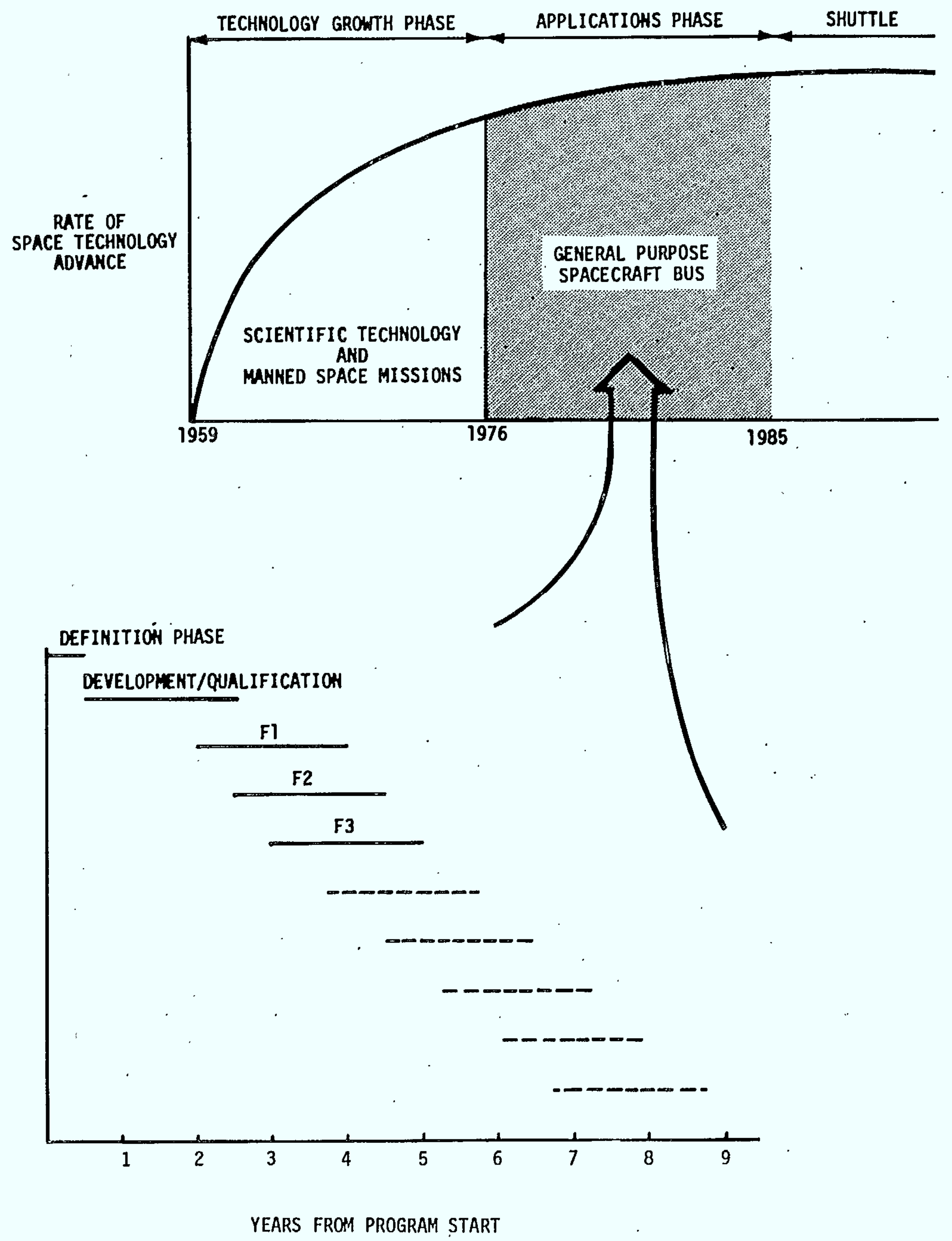
The following are budgetary estimated costs with fee, expressed in 1975 dollars, for the qualification model and the first three flight units, excluding integration and launch support of the satellite.

	Qual	Flight (X3)
Structure	1,673	1,448
DSA	2,751	7,629
Thermal	805	810
ACS	7,629	8,562
RCS	4,312	2,649
AKM	384	1,152
P.O.	2,082	964
	19,636	23,214

Costs - $42,990K for one qualification model and three flight models including working spares.

Five follow-on flight models would cost $32,000K.

G.P.B. PROJECTED SCHEDULE



SPAR

SCHEDULE SUMMARY

THE GENERAL PURPOSE BUS IS SUITED AND WELL TIMED TO MATCH THE PRESENT LEVEL OF CANADIAN CAPABILITY, DERIVED FROM PAST CANADIAN SATELLITE PROGRAMS.

From the commencement of the satellite space programs era in 1959 to the present day, the scene has been one of technology growth. The rate of growth of new technology is declining and the emphasis is now being placed more on the application of existing technology. The GPB incorporating recent developments can be launched within a 4 year period on conventional launch vehicles.

A further growth phase with the application of modularization concepts is expected when launching satellites by Shuttle occurs; however, this is not expected to be realized before 1985.

The GPB schedule is compatible with foreseen requirements for designing, manufacturing, testing and operating future Canadian communication satellites in the 1976-1985 time frame. Canada has the skills to complete all phases of the program which includes:

- system design, definition, and specification and subsystem development,
- bus subsystem and spacecraft qualification,
- flight bus and spacecraft delivery,
- spacecraft acceptance testing and launch support.

FEASIBILITY STUDY OF A

GENERAL PURPOSE BUS

STUDY REPORT

SPAR-R.677

This report was submitted to the Department of Communications in June 1975, and its contents are summarized on the opposite page.

Spar Aerospace Products Ltd.

SPAR-R.677

CONTENTS SUMMARY

NOTES

NOTES

GENERAL PURPOSE SPACECRAFT BUS:
EXECUTIVE SUMMARY.

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