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REQUIREMENTS FOR ARCTIC ICE AND OCEAN INFORMATION

IN 1969 AN EVENT OCCURRED THAT WOULD SEND A MAJOR SHOCK WAVE THROUGH THE CANADIAN ARCTIC AND WAKEN A SLEEPING GIANT - THE HYDROCARBON RESOURCES LYING BENEATH THE THICK MANTEL OF ICE AND SNOW.

THE DISCOVERY OF OIL ON ALASKA'S NORTH SLOPE IN THE LATE 1960'S LED THE US OIL INDUSTRY TO SEND THE SPECIALLY-DESIGN TANKER SS MANHATTAN THROUGH THE NORTHWEST PASSAGE IN 1969 TO PRUDHOE BAY. AS A CONSEQUENCE, OUR GOVERNMENT SAW A NEED TO PRESERVE CANADIAN SOVEREIGNTY IN THESE WATERS. THE FOLLOWING YEAR, CANADA PASSED THE ARCTIC WATERS POLLUTION PREVENTION ACT AND CLAIMED JURISDICTION OVER WATERS UP TO 100 NAUTICAL MILES FROM ITS ARCTIC COASTLINE. LATER THAT YEAR, MANHATTAN EMBARKED ON A SECOND VOYAGE THROUGH THE PASSAGE WHICH WAS LESS SUCCESSFUL THAN THE FIRST AND ONLY COVERED THE EASTERN HALF OF THE CANADIAN ARCTIC ARCHIPELAGO. SINCE THE MANHATTAN, THE ARCTIC WILL NEVER RETURN TO ITS EARLIER TRANQUIL STATE.

THESE EVENTS WERE THE FORERUNNER OF CURRENT ACTIVITIES IN THE CANADIAN ARCTIC AND SIGNALLED-IN AN ERA OF EXPANDING INVESTMENT AND EXPLORATION BEGINNING IN THE MACKENZIE DELTA AND LATER EXTENDING INTO THE BEAUFORT SEA, HIGH ARCTIC AND EAST COAST REGIONS. IN ORDER TO ACQUIRE SCIENTIFIC AND TECHNOLOGICAL DOMINANCE IN THESE CRITICAL AREAS, THE GOVERNMENT PROCLAIMED IN 1973 THAT "CANADA--SHALL ACHIEVE WORLD-RECOGNIZED EXCELLENCE IN OPERATIONS ON A BELOW ICE-COVERED WATERS", INCLUDING INITIATIVES

IN SUCH AREAS AS VESSEL DESIGN, ICE TOWING TANKS, ICE-RESISTANT STRUCTURES, REMOTE SENSING, ENVIRONMENTAL FORECASTING AND OF COURSE DEEP WATER DRILLING AND OIL POLLUTION COUNTERMEASURES.

THE DISCOVERY OF OIL AND GAS IN CANADA'S ARCTIC IN THE 1970s LED TO AN ACCELERATED CONCERN OVER THE TRANSPORTATION OF THESE RESOURCES TO MARKET. THE MORATORIUM ON A MACKENZIE VALLEY OIL PIPELINE RESULTING FROM THE BERGER COMMISSION DROVE THE BEAUFORT SEA CONSORTIUM, LED BY DOME PETROLEUM TO CONSIDER TRANSPORTATION OF THESE RESOURCES BY THE TANKER ALTERNATIVE THROUGH THE NORTHWEST PASSAGE. (I SHOULD ADD THAT THE MORATORIUM WILL BE OVER IN THE 1980s AND THE PIPELINE IS NOW BEING RECONSIDERED.) FOR NATURAL GAS, THE ALTERNATIVE TO THE POLAR GAS ROUTE IS THE LNG TANKER ALSO THROUGH THE NORTHWEST PASSAGE. THE ARCTIC PILOT PROJECT (APP) WAS ESTABLISHED TO TRANSPORT GAS PIPELINED TO BRIDPORT INLET ON MELVILLE ISLAND FROM THE HIGH ARCTIC AND THERE LIQUEFIED FOR TRANSPORT BY ICE-STRENGTHENED LNG TANKER TO A GASIFICATION AND STORAGE FACILITY EITHER AT GROS CACOUNA, QUEBEC, OR MELFORD PT., N.S. I SHOULD STRESS THAT BOTH THE DOME AND APP TANKER ALTERNATIVES ARE PROBABLY VIABLE ONLY IF SHIPPING CONTINUES YEAR ROUND.

THE NEED FOR YEAR ROUND, ALL-WEATHER SHIPPING THROUGH THE NORTHWEST PASSAGE OF CARGOES THAT COULD ENDANGER THE ENVIRONMENT IN THE EVENT OF AN ACCIDENT PRECIPITATES AN URGENT REQUIREMENT FOR MORE EXTENSIVE AND IMPROVED ARCTIC ICE AND OCEAN INFORMATION. DURING THE WINTER MONTHS, THE USUAL AIRCRAFT ICE PATROL SERVICE COULD NOT BE CONTINUED DUE TO DARKNESS AND FOUL

FLYING WEATHER WITHOUT BETTER SENSORS AND MORE AIRCRAFT TO COVER THE VAST AREAS INVOLVED. THESE LATTER ASPECTS SUGGESTED THE USE OF RADAR WHICH CAN PENETRATE DARKNESS AND CLOUDS TO SUPPLANT HUMAN VISION AND THE USE OF A SATELLITE PLATFORM TO PROVIDE THE NEEDED CONTINUOUS COVERAGE OVER WIDE AREAS. THUS RADARSAT WAS BORN, AND THE WORK I INTEND TO SUMMARIZE FOR YOU TODAY WAS SPONSORED BY THE RADARSAT PROJECT OFFICE, OPERATED BY THE FEDERAL DEPARTMENT OF ENERGY, MINES AND RESOURCES, BUT WORKING UNDER THE DIRECTION OF THE ATMOSPHERIC ENVIRONMENT SERVICE'S ICE BRANCH.

THE WORK BEGAN IN EARLY 1981 AND CONTINUES TODAY. THE INITIAL ACTIVITY STARTED BY SCANNING THE ENTIRE USER COMMUNITY TO ESTABLISH A BETTER UNDERSTANDING OF USER NEEDS AND THE HARD-CORE MINIMAL REQUIREMENTS OF THAT COMMUNITY FOR ICE AND OCEAN INFORMATION. TABLE 1 LISTS THE SEVEN USER GROUPS.

AT PRESENT COAST GUARD NEEDS ICE INFORMATION IN THE ARCTIC DURING SUMMER MONTHS TO SUPPORT THE RE-SUPPLY, EXPLORATION AND GENERAL SHIPPING, AND OFF THE EAST COAST AND IN THE GULF OF ST. LAWRENCE IN THE WINTER MONTHS TO HELP MAINTAIN GENERAL SHIPPING INTO EASTERN CANADIAN PORTS. OCEAN INFORMATION, PROVIDED BY THE CANADIAN DEFENCE FORCES METOC CENTRES ON BOTH COASTS IS NEEDED BY GENERAL SHIPPING AT ALL TIMES OF YEAR, PARTICULARLY IN THE NORTH ATLANTIC AND LABRADOR SEA.

I HAVE ALREADY MENTIONED THE RAISON D'ETRE FOR THIS WORK HAS BEEN OIL AND GAS SHIPPING. OFFSHORE DRILLING AND PRODUCTION

OPERATIONS ARE SITE SPECIFIC AND REQUIRE SUCH INFORMATION TO ASSIST IN THE FORECAST OF ICE AND OCEAN CONDITIONS IN ORDER TO PLAN OPERATIONS, AND FOR SAFETY. THE PRINCIPAL ENVIRONMENTAL HAZARDS OF OFFSHORE STRUCTURES ARE THE IMPINGEMENT OF PACK ICE AND ICEBERGS, WAVES AND WIND.

FISHERIES OPERATIONS NORMALLY ARE CARRIED OUT IN ICE-FREE WATERS, BUT THE DEEP SEA FLEET IS INCREASINGLY BECOMING INTERESTED IN THE LABRADOR FISHERIES WHERE THE BEST FISHING NECESSITATES BEING THERE WITH THE ICE.

THE AES NEEDS MORE OFFSHORE OCEAN DATA TO SUPPLEMENT ITS CURRENT SOURCES WHICH ARE MAINLY SHIPS OF OPPORTUNITY, DRILL RIGS AND A FEW BUOYS. WIND, WAVE AND SURFACE TEMPERATURE DATA WOULD IMPROVE THE ABILITY TO MODEL AND THUS FORECAST MET AND OCEAN PARAMETERS MORE ACCURATELY THAN AT PRESENT.

WHILE NATIONAL DEFENCE DOES NOT NORMALLY OPERATE WHERE ICE IS ENCOUNTERED, EXCEPT TO SUPPORT FISHERIES SURVEILLANCE, SEARCH AND RESCUE AND ENVIRONMENTAL EMERGENCY MEASURES, IT DOES OPERATE THE METEOROLOGICAL AND OCEANOGRAPHY CENTRES (METOC). THEY BROADCAST WAVE FORECASTS, SEA SURFACE TEMPERATURE AND OCEANS FEATURES SUCH AS INTERNAL WAVES AND THERMAL STRUCTURES TO ALL CIVILIAN AS WELL AS MILITARY USERS.

ICE AND OCEAN RESEARCHERS HAVE WIDELY VARYING INFORMATION NEEDS, SOME OF WHICH PARALLEL THOSE DESCRIBED ABOVE. ALSO THERE IS A REQUIREMENT FOR ARCHIVAL INFORMATION AS WELL AS REAL TIME DATA FOR ICE CLIMATOLOGY STUDIES AND WAVE CLIMATE ANALYSES, AS WELL AS MET CLIMATOLOGICAL RESEARCH AS IS DONE AT THE AES CANADIAN CLIMATE CENTRE.

SINCE OIL AND GAS SHIPPING ARE ONE OF THE PRINCIPAL DRIVERS BEHIND THE RADARSAT PROJECT, I HAVE LISTED ICE AND OCEAN PARAMETERS IN THEIR ORDER OF IMPORTANCE TO THIS USER GROUP IN TABLE 2. THESE PARAMETERS ARE WANTED FOR STRATEGIC PURPOSES, IN PLANNING AND SCHEDULING SHIP ACTIVITIES IN ADVANCE. THIS GROUP FACES THE OPTIMIZATION PROBLEM OF MINIMIZING TRANSIT TIME WITH AN ADEQUATE MARGIN OF SAFETY. A TYPICAL LNG TANKER COSTS IN THE ORDER OF \$300 MILLION, AND PROTECTION OF SUCH AN ASSET SUGGESTS THE NEED FOR EXTREME CAUTION, BUT THE MAINTENANCE OF A TIGHT SCHEDULE IS NECESSARY IN ORDER TO EARN A SATISFACTORY RETURN ON THAT ASSET. THUS ICE CHARACTERISTICS THAT COULD IMPEDE THE WAY OR PRESENT A HAZARD WHEN THE VESSEL IS UNDERWAY ARE HIGHEST IN PRIORITY TO THE CAPTAIN. THESE FACTORS SET THE ORDER OF PRIORITY OF THE LIST IN TABLE 2. (THE REASON ICEBERGS ARE SO FAR DOWN ON THE LIST IS THAT THE VESSEL MUST RELY ON CLOSE TACTICAL SURVEILLANCE, SINCE AIRBORNE RADAR IS NOT A RELIABLE ICEBERG DETECTOR).

ICE AND OCEAN PARAMETERS LIKE THOSE LISTED IN TABLE 2 ARE CONVEYED TO THE ICE NAVIGATOR OR CAPTAIN BY MEANS OF DATA TRANSMISSION CHANNELS CONTAINING SATELLITE OR TERRESTRIAL MICROWAVE LINKS. INFORMATION PRODUCTS GENERATED BY TELETYPE FACSIMILE EQUIPMENT ON BOARD THE VESSEL CAN BE IN THE FORM OF CHARTS OR ALPHANUMERIC TEXT. IN ORDER TO ESTABLISH THE APPROPRIATE FORM OF SUCH PRODUCTS THAT CONTAIN THE APPROPRIATE PARAMETERS, A WIDE CONSULTATIVE PROCESS WAS FOLLOWED WHICH RESULTED IN THE DEFINITION OF ELEVEN PRODUCTS SHOWN IN TABLE 3. THESE PRODUCTS ARE PROPOSED TO BE THE END OUTPUT OF THE FUTURE ICE AND OCEAN INFORMATION SYSTEM WHICH WOULD HAVE RADARSAT AS A PRIMARY SOURCE OF DATA. THE TITLE OF THESE PRODUCTS SUGGESTS THEIR CONTENT, AND I'LL SHOW AN EXAMPLE OF IMAGERY IN A MOMENT.

THE ICE ANALYSIS CHART IS THE PRODUCT NOW BEING PROVIDED BY AES DERIVED MAINLY FROM AIRBORNE ICE OBSERVERS AS WELL AS LANDSAT AND NOAA SATELLITE DATA. THIS CHART VIA FAX TRANSMISSIONS FROM COAST GUARD HF RADIO STATIONS IS USED EXTENSIVELY BY THE COAST GUARD AND GENERAL SHIPPING. IN SOME LOCATIONS, THE RECEPTION QUALITY IS POOR ACCORDING TO MANY CAPTAINS BEEN CONTACTED, AND THUS IMMEDIATE IMPROVEMENT IS NEEDED IN THE COMMUNICATIONS LINKS OF THE PRESENT SYSTEM.

FIGURE 1 DEPICTS THE EXISTING ICE AND OCEANS INFORMATION SYSTEM WHICH SERVES THE PRESENT DAY MARINE COMMUNITY BUT WHICH AVOIDS ARCTIC WATERS IN WINTER MONTHS. WITH YEAR-ROUND SHIPPING THROUGH THE NORTHWEST PASSAGE, RADARSAT OR ITS AIRCRAFT EQUIVALENT WILL HAVE TO BE ADDED, AND THIS IS SHOWN AT THE TOP OF THE FIGURE.

RADARSAT IS A CANADIAN-LED INTERNATIONAL SPACE PROGRAM TO ESTABLISH A SURVEILLANCE SATELLITE FOR THE PRIMARY PURPOSE OF SUPPORTING ARCTIC SHIPPING, BUT IT ALSO WILL BE OF VALUE TO LAND RESOURCE USERS. EXPECTED LAUNCH IS IN THE 1990 TIME FRAME. THE MAIN PAYLOAD OF THE SPACECRAFT WILL BE A SYNTHETIC APERTURE RADAR (SAR) HOWEVER, TABLE 4 LISTS OTHER SENSOR CANDIDATES. WHILE THE RADAR WILL PRODUCE VERY DETAILED IMAGES (25 M. RESOLUTION), THE MICROWAVE RADIOMETER WITH COARSER RESOLUTION (TYPICALLY 25-50 KM) YIELDS NUMERICAL DATA WHICH IS MORE READILY ASSIMILATED BY THE FORECAST MODELS TO BE USED BY AES.

THE OPTICAL SCANNER IS MAINLY NEEDED BY LAND RESOURCE USERS BUT ALSO IS A VALUABLE HIGH RESOLUTION (25 M.) TOOL FOR ICE USE WHEN THERE ARE NO CLOUDS. THE SCATTEROMETER CAN PROVIDE WIDE-AREA WAVE DATA (SIGNIFICANT WAVE HEIGHT AND DIRECTION). AN EXAMPLE OF SAR IMAGERY IS SHOWN IN FIGURE 2.

THE CHARACTERISTICS OF RADARSAT ARE LISTED IN TABLE 5. THE SPECIFIC SENSORS TO BE CARRIED WILL DEPEND ON THE PARTICIPATION OF OTHER COUNTRIES. FOR EXAMPLE, WHILE CANADA WILL PROVIDE THE KEY SENSOR - THE SAR - IT IS HOPED THAT THE US MAY CONTRIBUTE THE VIR AND/OR THE SCAT (AS WELL AS THE LAUNCH). SINCE WE ARE STILL LOOKING FOR OTHER PARTNERS, IT IS TOO EARLY TO FINALIZE ON THE SENSOR SUITE.

THE INITIAL RADARSAT IS INTENDED TO BE USED FOR AN OPERATIONAL DEMONSTRATION, AND IF SUCCESSFUL, FUTURE VERSIONS MAY DIFFER CONSIDERABLY AS WE GAIN EXPERIENCE. HOWEVER, WHILE A 1990 LAUNCH IS BEING PLANNED, RECENT EVENTS COULD ALTER THE TIMING SIGNIFICANTLY. HAVING ESTABLISHED ULTRA-AMBITIOUS PLANS FOR ARCTIC DEVELOPMENT, THE OIL AND GAS INDUSTRY DURING THE COURSE OF OUR WORK HAS HAD TO FACE THE NATIONAL ENERGY PROGRAM, EXTENDED (AND NOW TERMINATED) NEB HEARINGS, CANCELLATION OF MEGA-PROJECTS, HIGH INTEREST RATES AND CRUSHING DEBTS, JURISDICTIONAL DISPUTES (AS IN NEWFOUNDLAND), POTENTIAL MARITIME SELF-SUFFICIENCY IN GAS FROM THE SCOTIAN SHELF, ALL LEADING TO A CURRENT DEPRESSION IN THE INDUSTRY. THE BASIC IMPACT OF

SUCH EVENTS IS TO ALTER THE TIMING ON DEVELOPMENT AND THUS WHEN THERE WILL BE A NEED FOR MORE EXTENSIVE ICE INFORMATION. EVENTS ARE MOVING TO WHERE THE DEVELOPMENT OF CANADIAN PETROLEUM RESOURCES IN THE ARCTIC COULD BE DELAYED INTO THE NEXT CENTURY.

DESPITE THE UNCERTAINTY, I BELIEVE THERE IS A WEALTH OF OPPORTUNITY FOR SUPPORTING SECTORS IN THE CANADIAN HIGH TECHNOLOGY COMMUNITY. FIRST AND FOREMOST IS THE NEED FOR IMPROVED COMMUNICATION SYSTEMS. THE CHALLENGE HERE IS ONE OF PROVIDING SYSTEMS THAT CAN BE AFFORDED BY THE WIDE SPECTRUM OF USERS RANGING FROM THE POOREST OF FISHERMAN TO THE ULTRA-SOPHISTICATED ICE-BREAKING TANKERS ACHIEVING PERFORMANCE COMMENSURATE WITH NEED. INCLUDED IS THE MEANS OF RECORDING CHARTS AND OTHER GRAPHICS. THE PLUMMETING UNIT COSTS OF MICROPROCESSOR CHIPS AND RELATED TECHNOLOGY SHOULD BE REFLECTED IN WHAT MIGHT BE AVAILABLE TO ARCTIC OPERATORS.

OTHER OPPORTUNITIES EXIST IN IMPROVED SENSORS - PARTICULARLY FOR SMALL ICEBERGS KNOW TECHNICALLY AS BERGY BITS AND GROWLERS - AND OTHER VESSEL-MOUNTED SYSTEMS NEEDED FOR SAFETY IN CLOSE-TACTIAL SENSE. CONSIDERING THE MULTI-BILLION DOLLAR INVESTMENTS INVOLVED IN THE OFFSHORE, THE CANADIAN INFORMATION-RELATED INDUSTRIES ARE IN A STRONG POSITION TO TAKE ADVANTAGE OF THE LEVERAGE PROVIDED BY OUR SOVEREIGN RESOURCES.

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