NPOESS

National Polor-orbiting Operational Environmental Satellite System

IPO & NASA Fiber Telecommunications Service to Svalbard, Norway

Presented by

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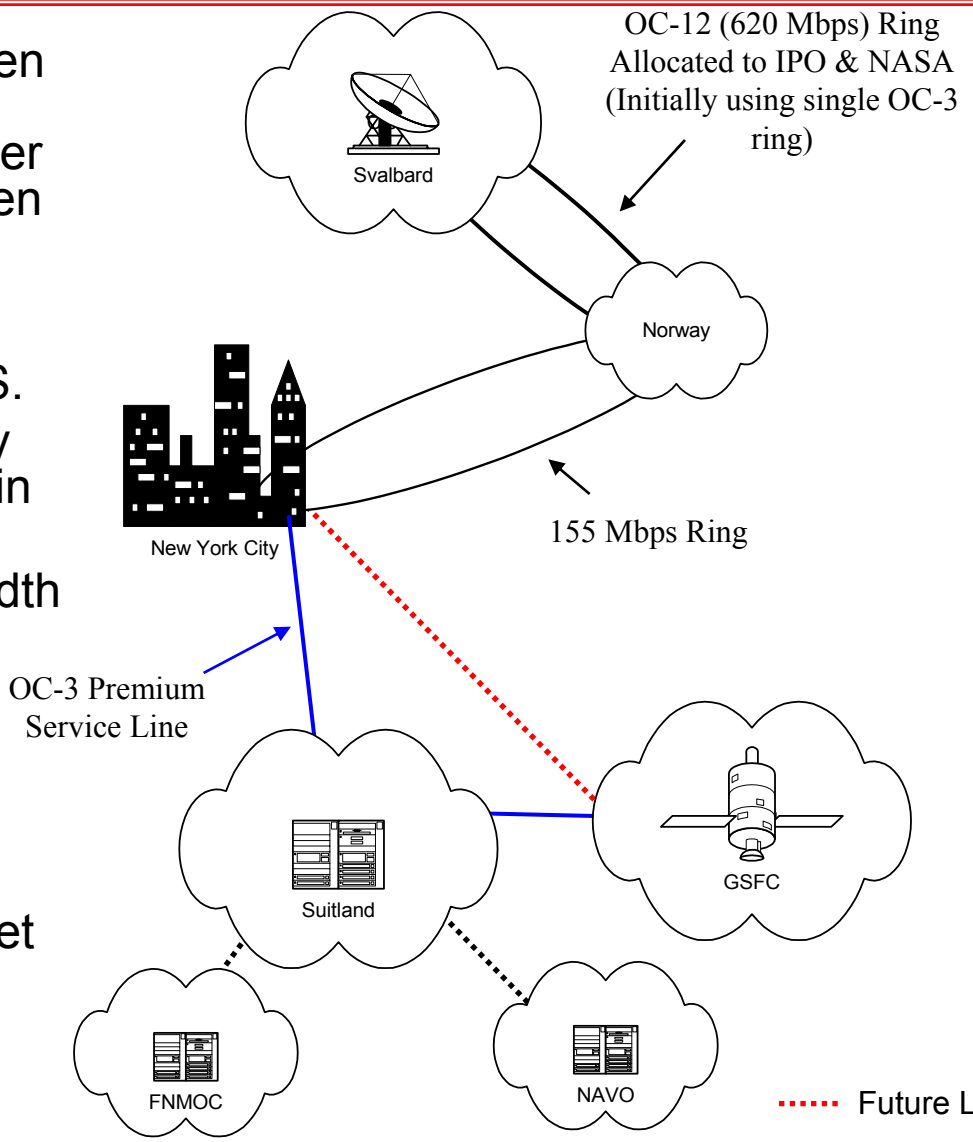
Where is Svalbard?

SvalSat on the Plateau

Overview

- An international partnership between IPO, NASA, and the Norwegian Space Agency made possible a fiber optical communications link between Svalbard and mainland Norway, enabling all partners to eliminate expensive satellite communication links between Svalbard and the US.
- The link between Mainland Norway and Svalbard became operational in January 2004, and is in use today.
- NASA & IPO will share the bandwidth as follows:
  - From now thru NPP Operations
    - NASA 90 Mbps, IPO 57 Mbps
  - After NPOESS Ground Readiness
    - NASA 57 Mbps, IPO 90
- NASA & IPO may jointly agree to increase the total bandwidth to meet their cumulative needs



Fiber Circuits

Svalbard to Mainland Norway

- 1+1 protected, diversely routed fiber “ring”
- IPO & NASA each given an initial capacity of OC-3 (155 Mbps) through 2029 (up to OC-12 available for IPO & NASA use) at no additional charge
- Currently IPO & NASA sharing a single OC-3 (1+1 protected)

Norway to US (New York City)

- IPO & NASA sharing a single OC-3 “ring” (1+1), funded on a yearly basis

NYC to Suitland/GSFC

- IPO & NASA sharing a single OC-3 “premium service” link to Suitland
- Link to the GSFC procured by NISN

Additional capacity and/or missions can be easily added to the system

- The cost to the new missions would be a share of the circuit costs, plus the Operations and Sustainment costs
  - Little or no additional hardware costs

IPO Responsibilities

- Design, document, install, integrate, test, operate and maintain a multi-mission fiber network telecommunication service from Svalbard to the Continental US for shared use between NASA and NPOESS IPO.
- Provide a network service that meets or exceeds the following performance requirements between the NASA demarcation at Svalbard and the NASA demarcation in the Continental US:
  - Have an availability of 99.98% or better, on a monthly average
  - Have a packet latency round trip time of 300 msec or less, on a monthly average.
  - Have 0.001% packet loss or less, on a monthly average.
  - Support Jumbo Frames (up to 9216 bytes per frame)
  - Have an automatic fail-over restoral time of less than 1 minute
  - Have the capability to identify failures within 20 minutes and begin service restoration
  - Not be interrupted or degraded before, during, or after any upgrades, any transitions from Initial Phase to Final Phase, or any integration of additional missions
- Provide the 24x7 Operations and Sustainment for the fiber network telecommunications service.
- Share half of the recurring costs for the telecommunications service (circuits) as well as half of the end-to-end system Operations and Sustainment costs.

NASA Responsibilities

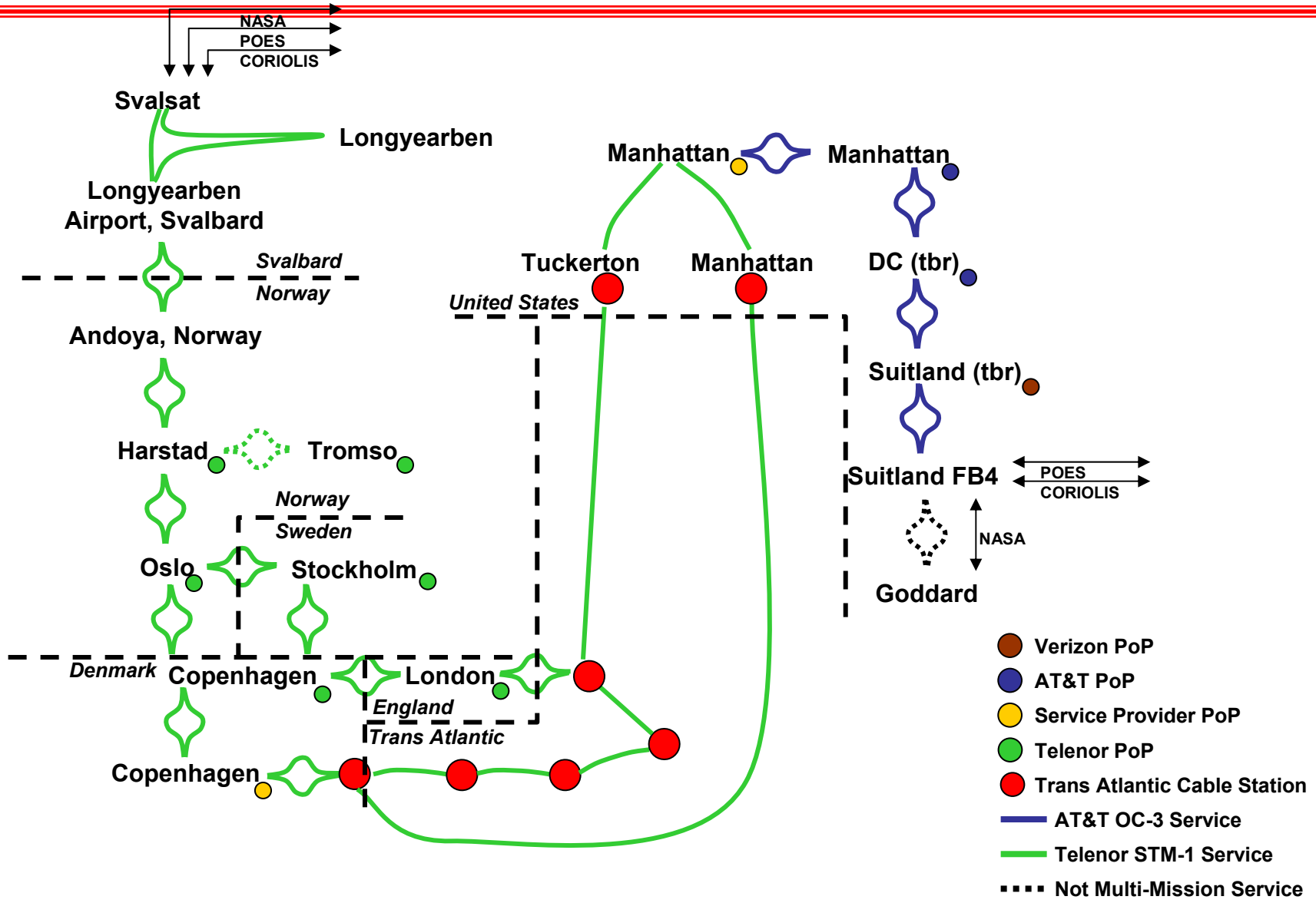
- Share half of the recurring costs for the telecommunications service (circuits) as well as half of the end-to-end system Operations and Sustainment costs.

- Assist the IPO in test and acceptance of the fiber network telecommunications service.

Development Status

- Initial Phase (GSFC Connected via Suitland):
  - All IPO network equipment installed
  - Preparing for final testing and acceptance
  - Expecting system complete on or about 30 June 2004
- 24x7 Ops to begin 1 July 2004
- NASA Installation and testing during July 2004
- Final Phase (GSFC direct connect to NYC using MPLS):
  - Transition to final architecture expected during Late Summer 2005

Fiber Overview



Fiber Architecture

- Initial Phase:
  - Telenor STM-1 (155Mbps) SONET/SDH ring from Svalsat to Manhattan
    - Full ring for each hop from Svalsat
    - Uses transatlantic fiber – landfall in Manhattan and Tuckerton, NJ
    - Terminates at Service Provider PoP in Manhattan
  - AT&T OC-3c (155Mbps) SONET ring from service provider demarc to Suitland FB4
    - Verizon providing local loop access onto Suitland
    - High availability, premium service option

Fiber Architecture

- Final Phase:
  - Telenor service same as Initial Phase
  - AT&T to provide OC-3c access from service provider PoP to AT&T NYC PoP
    - Will split NASA traffic to NASA provided interface at AT&T NYC PoP
    - IPO traffic will transition to AT&T MPLS backbone at NYC PoP
      - Separate MPLS VPNs for each Mission (For example, Coriolis, POES and NPP)
    - AT&T will install access circuit to MPLS backbone at NSOF

WAN Protocols

Physical and Layer 2

- SONET/SDH over fiber as concatenated STM-1/OC-3
- Routers at Svalbard will apply mission unique MPLS labels on each packet based upon incoming interface
  - Coriolis, POES and NPP will apply labels based upon incoming Ethernet VLAN IDs
    - VLANs trunked over same Ethernet port
    - Separate VLAN(s) for each mission
  - NASA – will apply label based upon incoming interface
- NASA using Jumbo Frames (about 9KB) on LAN and WAN
- Routers support AToM (Any Transport over MPLS)
  - Current Ethernet switch card and Upgraded Supervisor cards support AToM

Routing

- Will use MultiProtocol-BGP (M-BGP) between routers at Svalbard and Suitland to support MPLS VPN re-routing if failure

Network Security

- Multiprotocol Label Switching (MPLS) VPN
  - MPLS labels packets with path identifiers, not destination endpoints, NPOESS network topology is not revealed to outside world
  - Intrusion detection provided as an additional layer of security
    - AT&T Network Operations Center (NOC) monitors network traffic at processing centers for irregularities, alerts go to MMC over status link

Network Security

- Data separation between missions maintained at Layer 2
  - Separate MPLS VPNs across WAN
  - Layer 2 VLANs for non-NASA data on local Ethernet
    - VLANs trunked between switches, Packetshaper and routers
  - MPLS pseudowire for NASA data on local Ethernet
    - Separate Ethernet interfaces for NASA interfaces
    - NASA applies several “private” MPLS labels to maintain traffic separation

Bandwidth Management

Combination of static and dynamic bandwidth management

- Bandwidth is allocated based upon data rate coming into and going out of device – not on payload rate
  - Bandwidth at router and Packetshaper is measured with all protocol overhead – payload bandwidth will be less
- Routers at Svalbard and Suitland use Weighted Fair Queuing (WFQ) to control bandwidth at macro level on output interfaces
  - 2 Mbps to Management/Monitoring
  - 90 Mbps to NASA
  - 55 Mbps to IPO
- Packetshapers manage bandwidth within IPO allocation at Svalbard
  - TCP senders will react to congestion control from Packetshapers to control rate
  - Other protocols (UDP, etc.) must stay within allocation to avoid possibility of lost packets
  - Minimum bandwidth allocations – applications can burst to available bandwidth
    - 5Mbps Coriolis
    - 40Mbps NPP