Honeywell

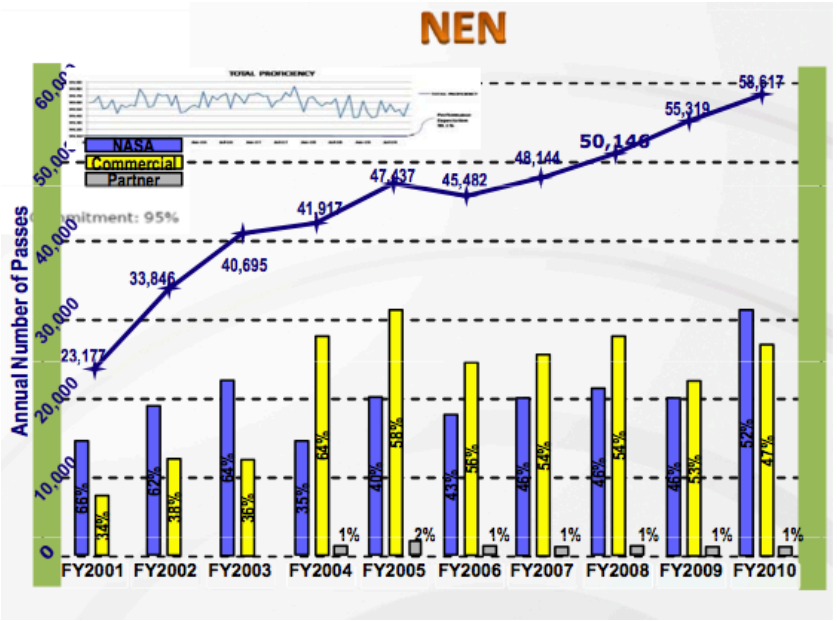
EXOSTRATEGIES

Collaborating Networks: Assessing the Value of Using Networks Outside of Your Span of Control

Dan Heimerdinger, Ph.D., Exostrategies, Inc.
Shawn Hosp, Exostrategies, Inc.
Debra Pomerleau, HTSI
Kevin Newland, HTSI

Background

- Policy and practice are pointing more and more towards the pragmatism of network federation
- Discussed at the SATOPS Interface Coordination Working Group Meeting on July 28, 2010 at the Aerospace Corporation
  - Policy:
    - Ms. Christine Bonniksen (OSD/ NII) indicated that federation was likely to be inevitable owing to diminished budgets
  - Practice:
    - Jon Walker (NASA SCaN) showed that since 1999 when commercialization and outsourcing commenced, commercial system utilization now accounts for almost half of all supports



Value of Federation

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- Federation requires interoperable space and ground systems
- Motivation: Reducing the total costs to the program and institution
  - Federation means sharing assets
  - Sharing assets means allocating asset costs across a broader user base
  - Allocating costs across a broader user base means reducing one's total cost of asset ownership or asset use
- However, there is no such thing as a free lunch
  - Federation means sharing assets which inevitably results in increased network utilization
  - Mission assurance is all about risk management—how can an organization plan on using another network with a high probability of success?

Modeling Federation

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- Exostrategies developed a satellite TT&C network modeling tool called SONIC for Satellite Operations Network and Infrastructure Costing toolkit
  - Simulate the ensemble satellite demand for network TT&C services
  - Identify satellite/ground station conjunction opportunities
  - Allocate contact demand
  - Collect metrics that determine loading success
- Federation analyses takes advantage of an algorithm developed for use of commercial or other network antennas for network augmentation
  - Commercial providers not likely to provide insight into other customer loading requirements or pricing other than a ***maximum availability***
  - Other networks may only provide overall loading statistics for availability
- Probabilistic Antenna Allocation (PAA) algorithm
  - SONIC constructs schedulable windows at antennas based on availability with scheduling opportunities for federated use
  - User demand can be overlaid onto opportunities to develop notional daily schedules
  - Each schedule is an "instance" to be iterated for statistical significance
  - Monte Carlo processes are used to provide expected value, confidence in the mean, and associated simulation statistics

This methodology makes the federated user the *lowest priority user*—in essence it provides host network usage on a no conflict basis and reduces risk to the host network's primary customers.

Creating Scheduling Windows

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- SONIC postulates availabilities based on antenna availability
  - Additional parameters needed to identify the antenna utilization including typical pass duration and pre/post-pass times
  - Can also take mix of LEO, HEO, and GEO satellites
- 25%, 50%, and 75% utilization examples shown using LEO mission parameters (visibility limited supports)

Notional Scenario

- An agency seeks to reduce its reliance on foreign systems as well as eliminate ground station assets for 14 polar LEO systems
  - Mixture of old and new systems requires 118 supports per day at a minimum of 5 minutes per TT&C support
  - Would like to see:
    - To what level the AFSCN could potentially support the missions
    - Whether that support might be sufficient to support its objectives
- Assumption: The AFSCN is interested if the civil agency is willing to:
  - Pay for full interoperability with AFSCN
  - Reimburse the AFSCN for its use of the network and cost of data transport
- Assuming that the AFSCN is initially loaded at at 50%, 60%, or 70% at each antenna, what level of support is possible?

Satellite	Daily Supports
Sunsynch - 1	6
Sunsynch - 2	6
Sunsynch - 3	6
Sunsynch - 4	8
Sunsynch - 5	8
Sunsynch - 6	12
Sunsynch - 7	12
LEO - 8	8
LEO - 9	8
Sunsynch - 10	6
Sunsynch - 11	6
Sunsynch - 12	8
Sunsynch - 13	12
Sunsynch - 14	12
Total	118

Civil Agency's Mission Impact

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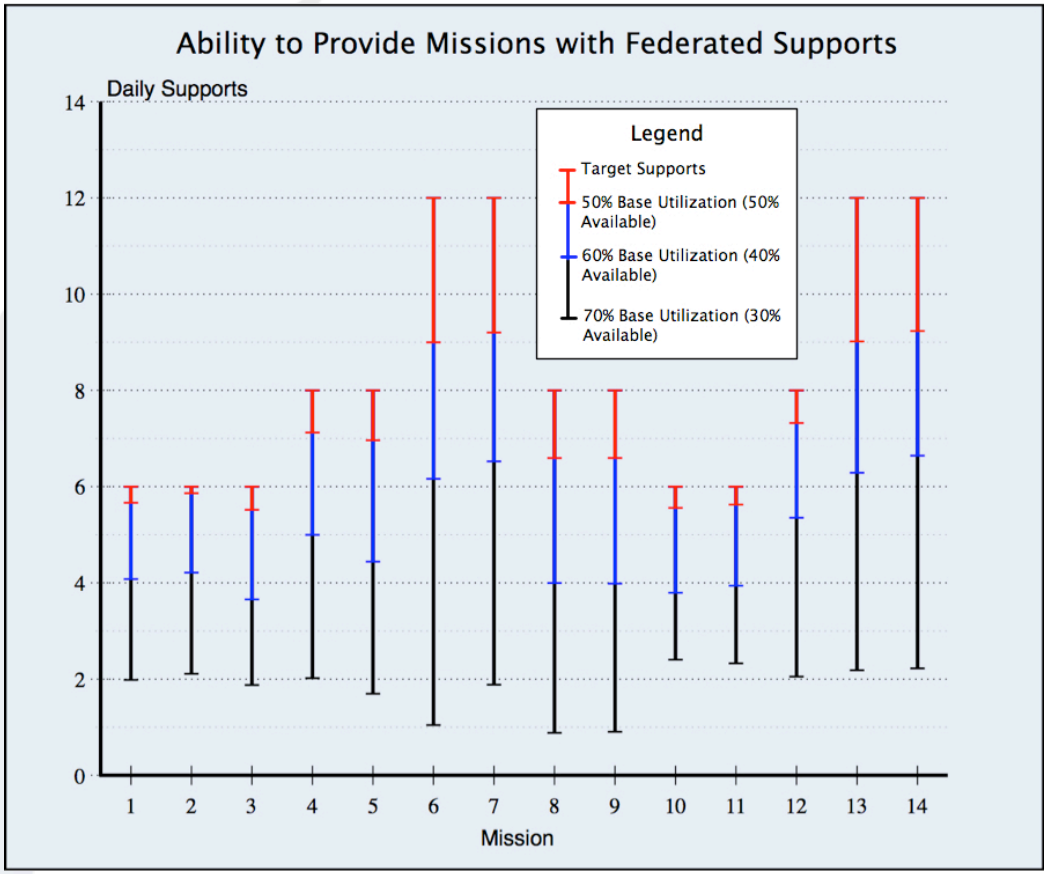
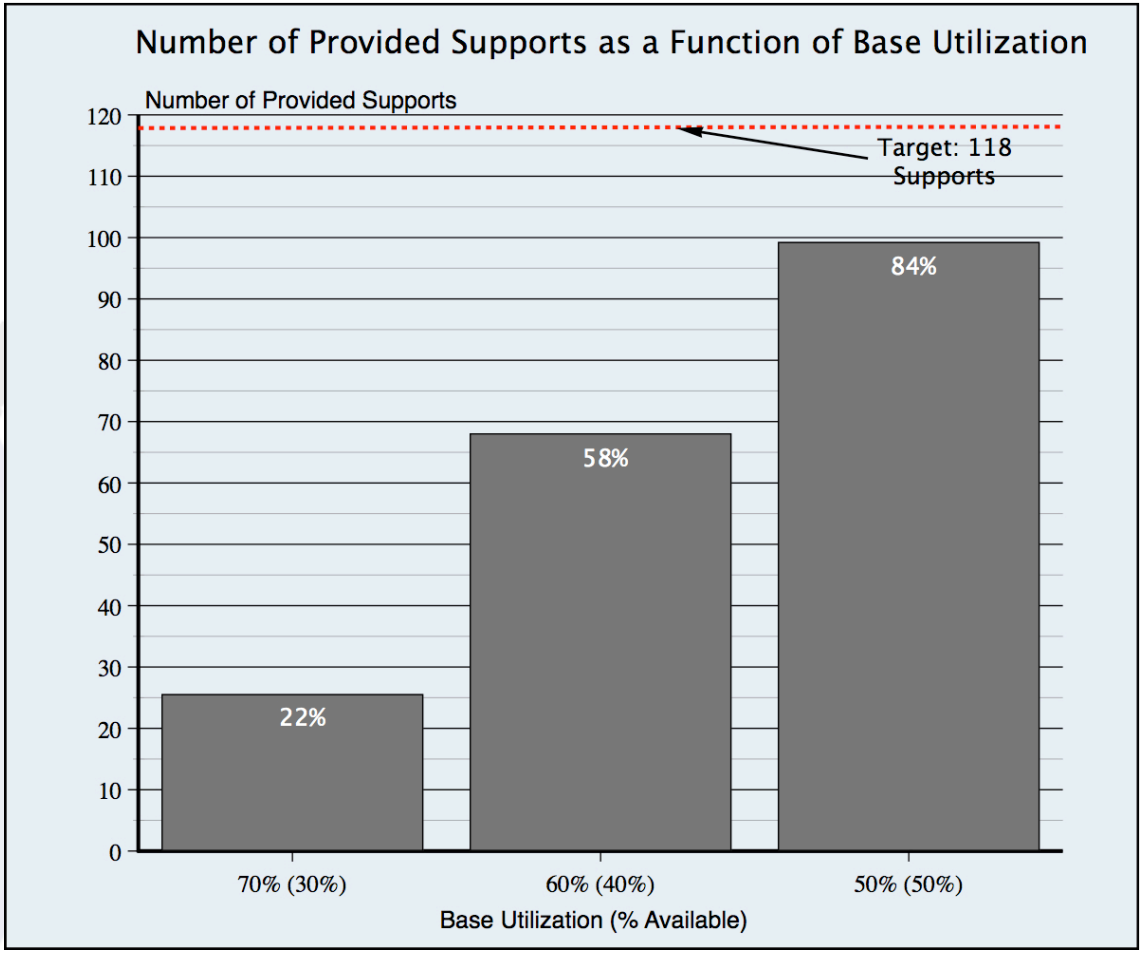
- Cannot handle all mission support requests; however
  - Can support a significant number even at high base utilization
- Questions are ultimately
  - How many supports becomes significant?
  - What is the impact to the host network, the AFSCN?
  - How much cost savings can this really provide?



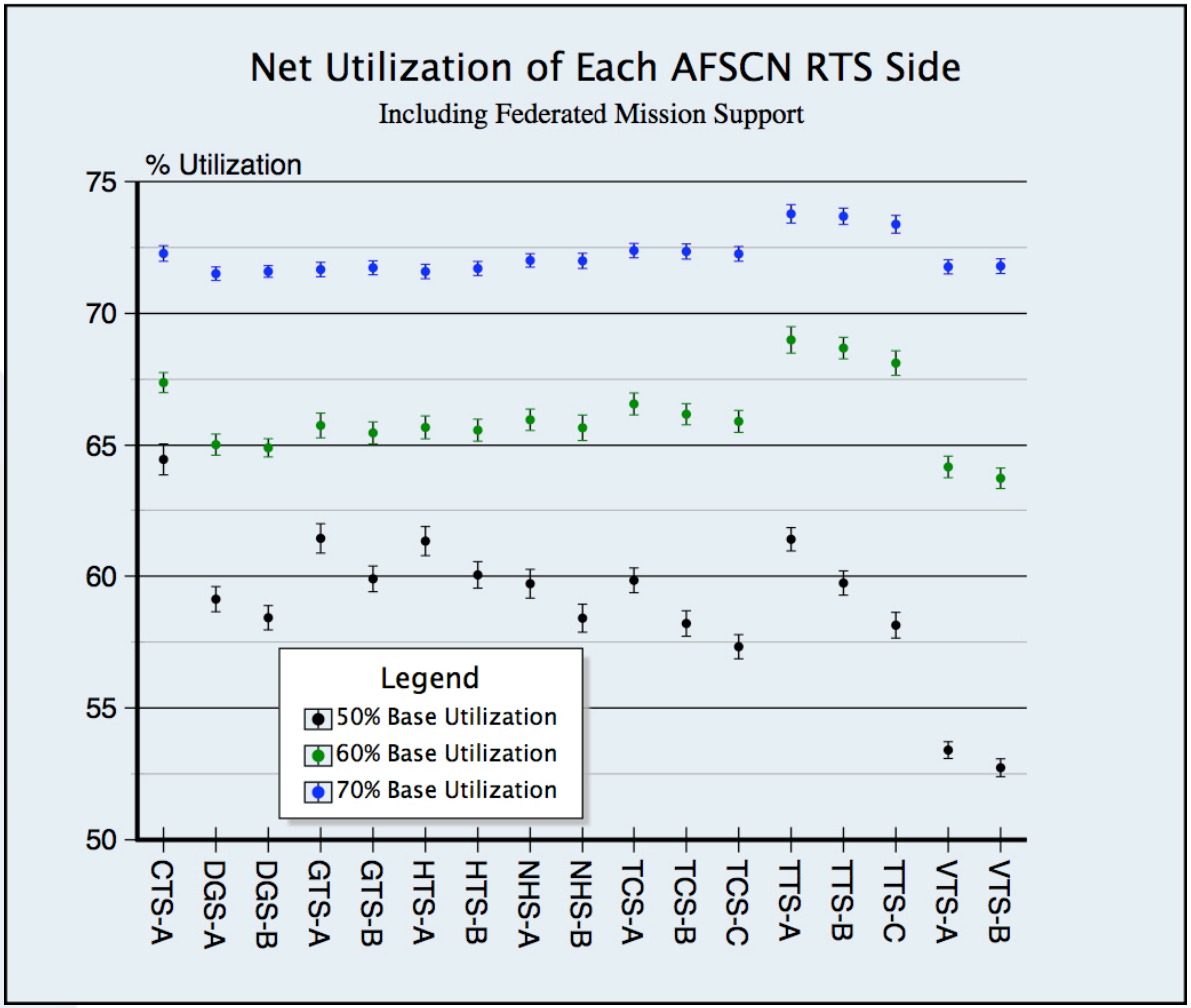
Total Supports

- As expected, higher baseline utilizations offer less opportunity for support
  - However even a 30% availability can provide almost a quarter offload, on average
- A 60% baseline utilization can provide significant number of supports
  - Almost 60% of the required supports (or 68.1 supports per day)
- A 50% baseline utilization can offload all but 16% for a total of 99.3 supports per day on average!
- The question is, what does this do to the host network in terms of site utilization?



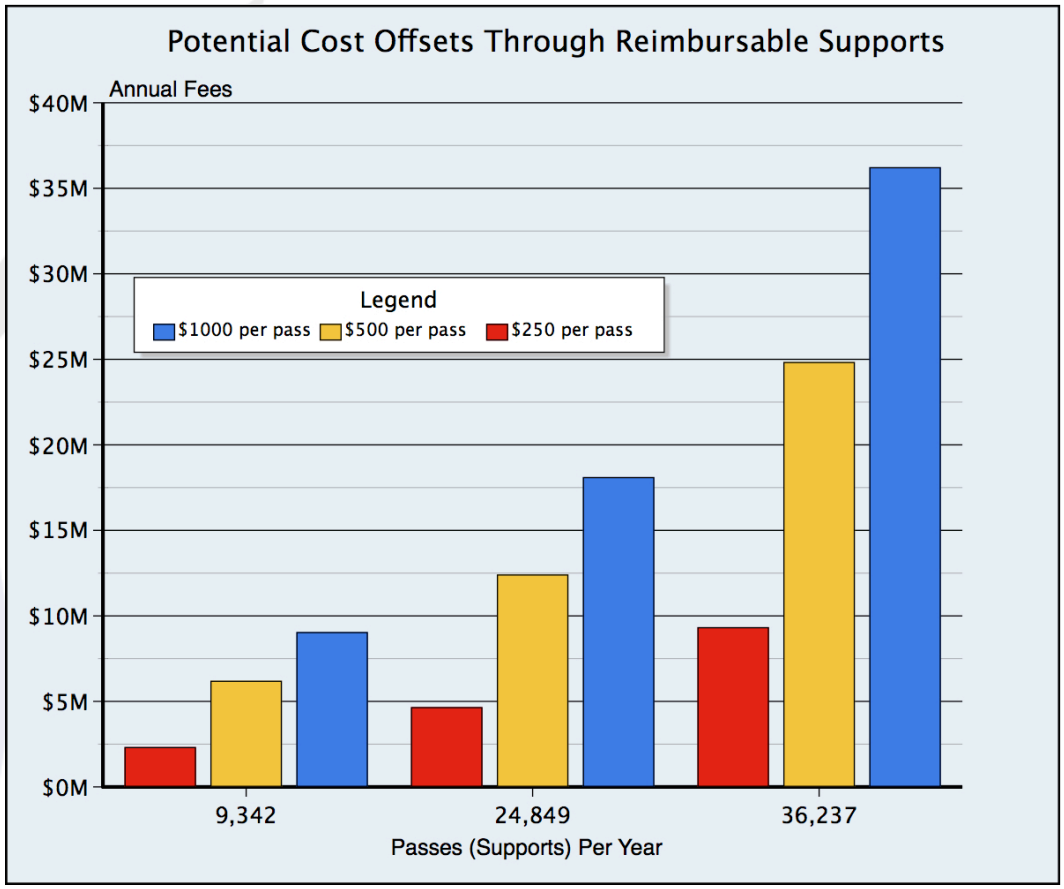
Site Utilization

- The lower the availability, the lower the average change in utilization
  - 70% to 72.2%
  - 60% to 66.1%
  - 50% to 59.0%
- Variation exists across sites due to scheduling algorithm as well as orbital dynamics
- The ability to maximize availability through reductions in pre pass time and early release of spacecraft on the host network could be of great cost benefit…



Why Sacrifice Availability

- Cost savings could be very significant given the number of annual supports
  - 25.6/day = 9,342/year
  - 68.1/day = 24,849/year
  - 99.3/day = 36,236/year
  - Of course there must be cost savings to the funding agency through reduced cost of asset ownership and management
- Potential to fund additional capabilities to improve efficiencies and reduce pass support requirements
- Opportunities to fund architectural evolution for further federation and cost savings



Conclusions

- Probabilistic availability modeling can provide a means to estimate the potential for network federation
- The impact on the host network can be estimated from the standpoint of utilization and cost
  - Other factors need to be addressed including
    - Future host network demand
    - The value of more effective prepass and pass utilization and release on network availability
    - Requirements for increased communications throughput/bandwidth
  - Costs to provide interoperability must be addressed
    - These too could be reimbursable
    - The impact on overall AFSCN budgetary constraints could be substantial
- Federation can be a powerful opportunity for both the host and user

Backup Slides

Limiting Case

- At some point, it becomes difficult to further load an antenna
  - Pre/post-pass durations and TT&C events limit available windows for user supports
  - Can be dependent on the mixture of GEO and LEO supports since GEO supports may offer more flexibility since they are not visibility limited
- For a LEO antenna, it is difficult to load it beyond 75% utilization