Shelter Technology & Operational Energy

Joint Committee on Tactical Shelters
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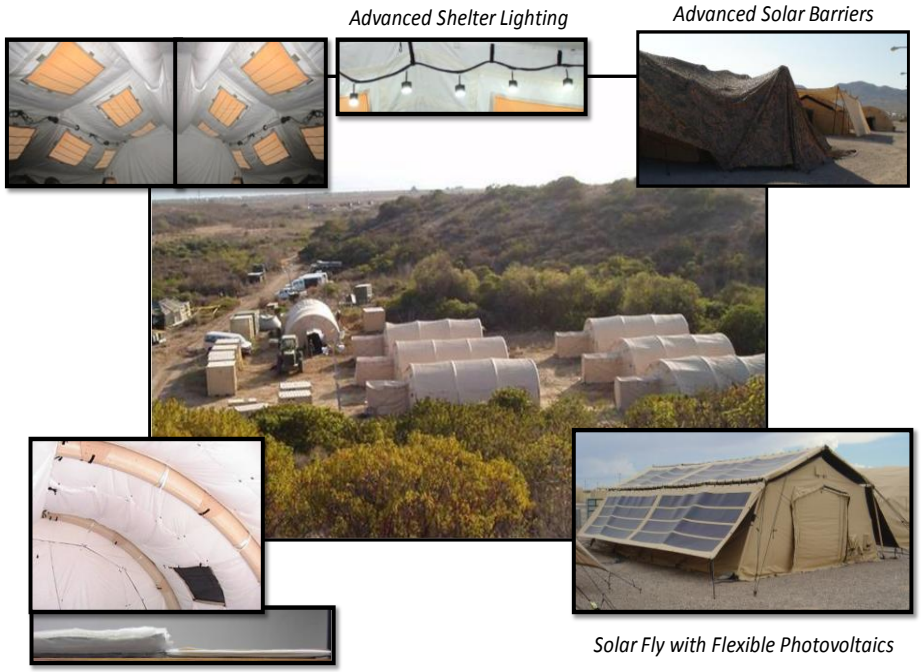
Discussion Topics

- Advanced, Energy Efficient Shelter Update
- Next Generation Shelter Design
- Other Related Science & Technology Projects
- JOCOTAS Science & Technology Coordination

Advanced, Energy Efficient Shelter Systems for Contingency Basing & Other Applications

Operational Energy Capabilities Improvement Fund

- Joint Service, multi-organizational program to address inefficiencies with energy usage and fuel consumption of shelter systems
- Culmination of lessons learned will lead to optimized shelter systems to meet Joint Service needs



Program Provides:

- Initial Demonstrations – Operational evaluation of complete, state-of-the-art shelter systems when used by operators in the field
- Technology Development – Mature DOD and industry developed technologies to advance the state-of-the-art to reduce logistics/cost impact and further reduce fuel consumption on the battlefield
- Follow On Demonstrations – Leverage lessons learned in the Initial Demonstrations and Technology Development into optimized shelter systems and validate in the AOR

Warfighter Payoff:

- Energy efficient shelter systems that are optimized to reduce fuel consumption on the battlefield and manpower requirements for the Warfighter
- 50% reduction in shelter system power consumption
- 36M gal/year fuel savings
- Savings to Investment Ratio (SIR) = 15.3:1

Initial Demonstrations

Objective: Reduce energy consumption of shelter systems; demonstrate the energy savings that are achievable today in a relevant environment

- Leverage technologies developed and matured by the Services
- Address lessons learned through Net Zero Joint Capabilities Technology Demonstration
- Quantify the current state-of-the-art in a relevant environment

Technologies:

- Solar Shades
- Thermal Insulation
- Right-Sized Environmental Control Units
- Energy Efficient Lighting

Tasks:

- Build and field shelter systems
- Demonstration & Testing
    - Temperatures
    - Power Consumption
    - Technical Performance
- Enable commanders to see & assess technologies

Technical Challenge: Demonstrate fully integrated systems optimized for performance, energy efficiency, and minimized manpower requirements.

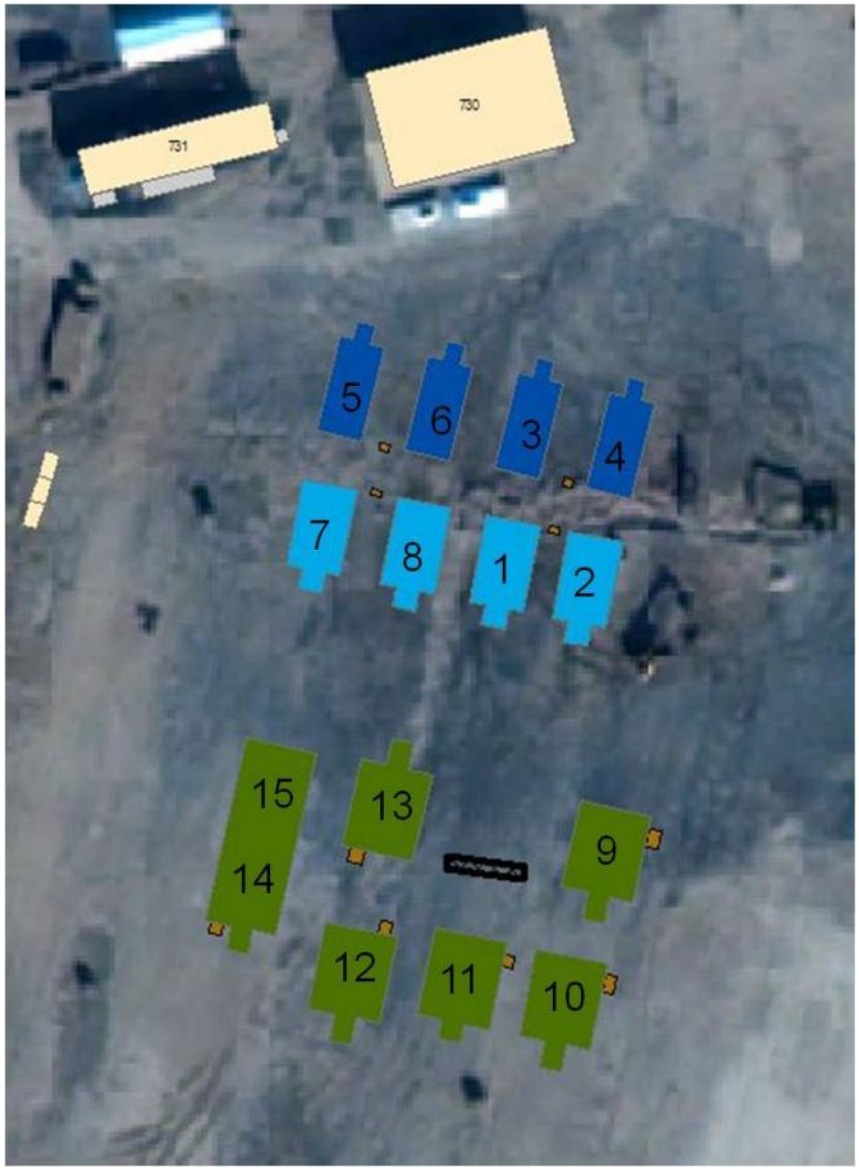
Technology Accomplishments: Initial Demonstrations

- 15 Shelter systems fabricated: varying configurations for comparison
  - A-frame and Quonset Hut shape shelters
  - Solar barriers and thermal insulation
  - Three different environmental control units
  - Three different lighting sets
  - Photovoltaics
  - Two shelters on one environmental control unit

- Form, fit, function at Tyndall AFB in July 2013
  - Power up and operate shelter systems
  - Validate data collection equipment operation
- Deployment to AOR August 2013
  - Coordinated with AFCENT

AOR Demo Site

Aerial Depiction of Site As Built



Shelters 1 & 2 – Air Force
Not to be Occupied
Gable Shelters
Fly
Cooled by 1 ECU

Shelters 3 & 4 – Air Force
Not to be Occupied
Gable Style Shelters
PV Flys
Cooled by 1 ECU

Shelters 5 & 6 – Air Force
Occupancy Allowed
Gable Style Shelters
PV Flys
Cooled by 1 ECU

Shelters 7 & 8 - - Air Force
Occupancy Allowed
Barrel Style Shelters
Fly
Cooled by 1 ECU

Shelter 9 – Army
Not to be Occupied
Gable Style Shelter
Fly
Cooled by 1 ECU

Shelter 10 – Army
Not to be Occupied
Gable Style Shelter
Fly
Cooled by 1 ECU

Shelter 11 – Army
Not to be Occupied
Gable Style Shelter
Fly
Cooled by 1 ECU

Shelter 12 – Army
Occupancy Allowed
Barrel Style AirBeam Shelter
Fly
Ground PV
Cooled by 1 ECU

Shelter 13 – Army
Occupancy Allowed
Barrel Style AirBeam Shelter
Fly
Cooled by 1 ECU

Shelter 14 & 15 – Army
Occupancy Allowed
Barrel Style AirBeam Super Shelter
Fly
Cooled by 1 ECU

AOR Evaluation Site

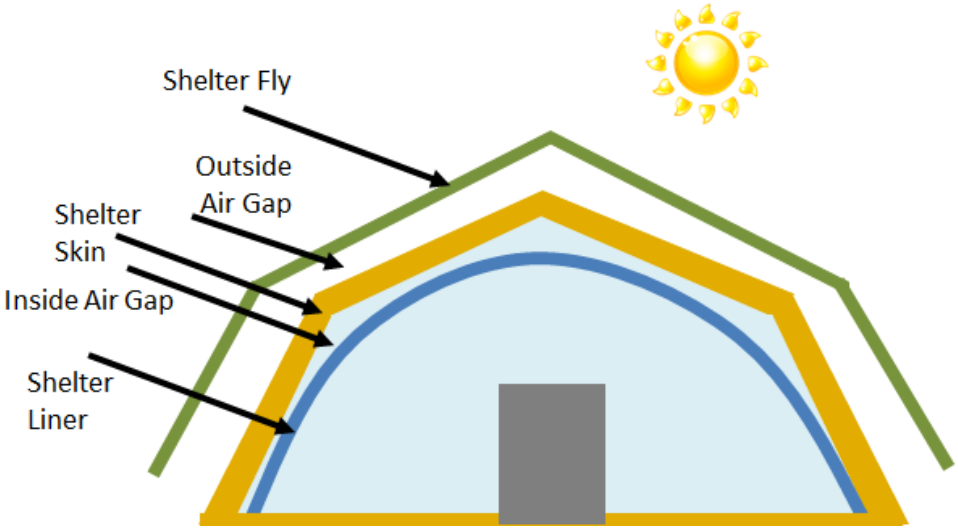
Modeling & Simulation

Technology Development: Modeling, Simulation & Analysis

Objective: Establish computational models of the interaction between the shelter fly, shelter skin and thermal liner in order to create a more efficient design. The combined thermal and fluid computational model will allow us to conduct numerical experiments to optimize the different layers' designs. The models will take into account thermal conductance, and radiation.

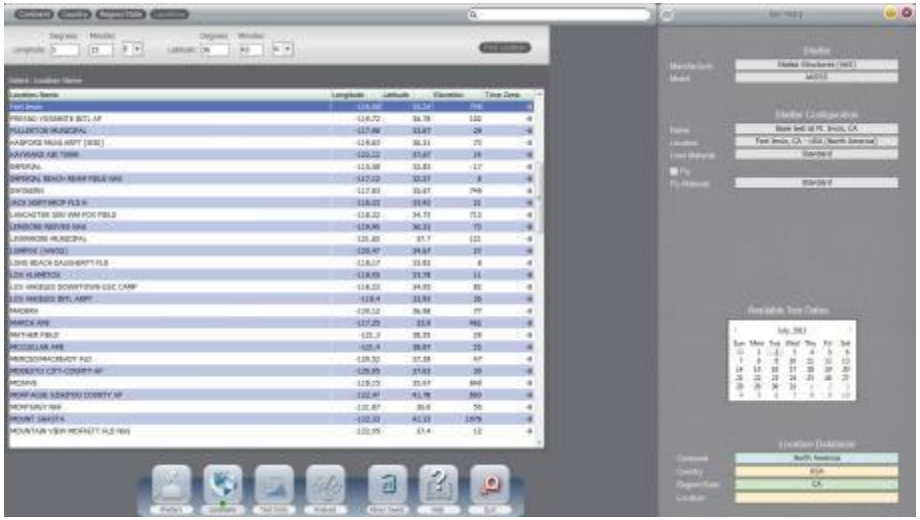
Tasks

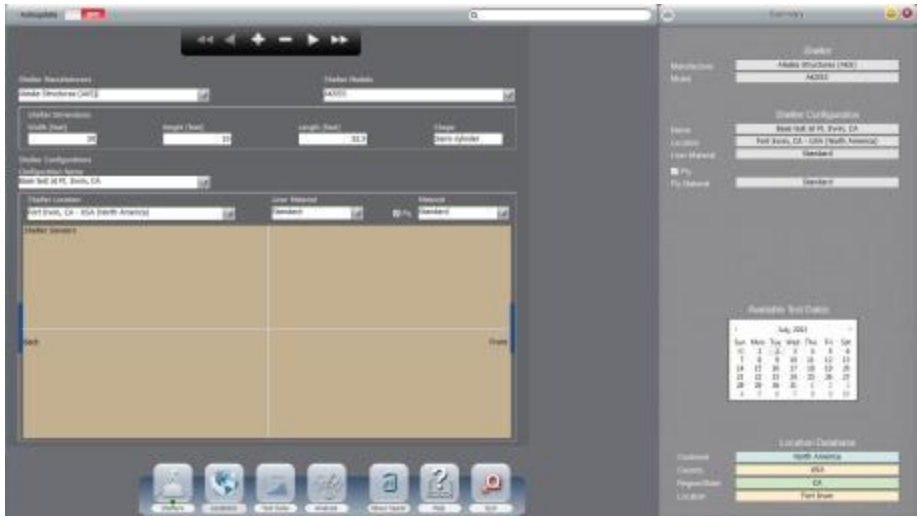
- Computational modeling of the interactions between the layers
- Thermal & fluid modeling to optimize the design of the layers
- Design for minimized air infiltration
- Intelligent occupancy modeling



Technology Accomplishments: Modeling & Simulation

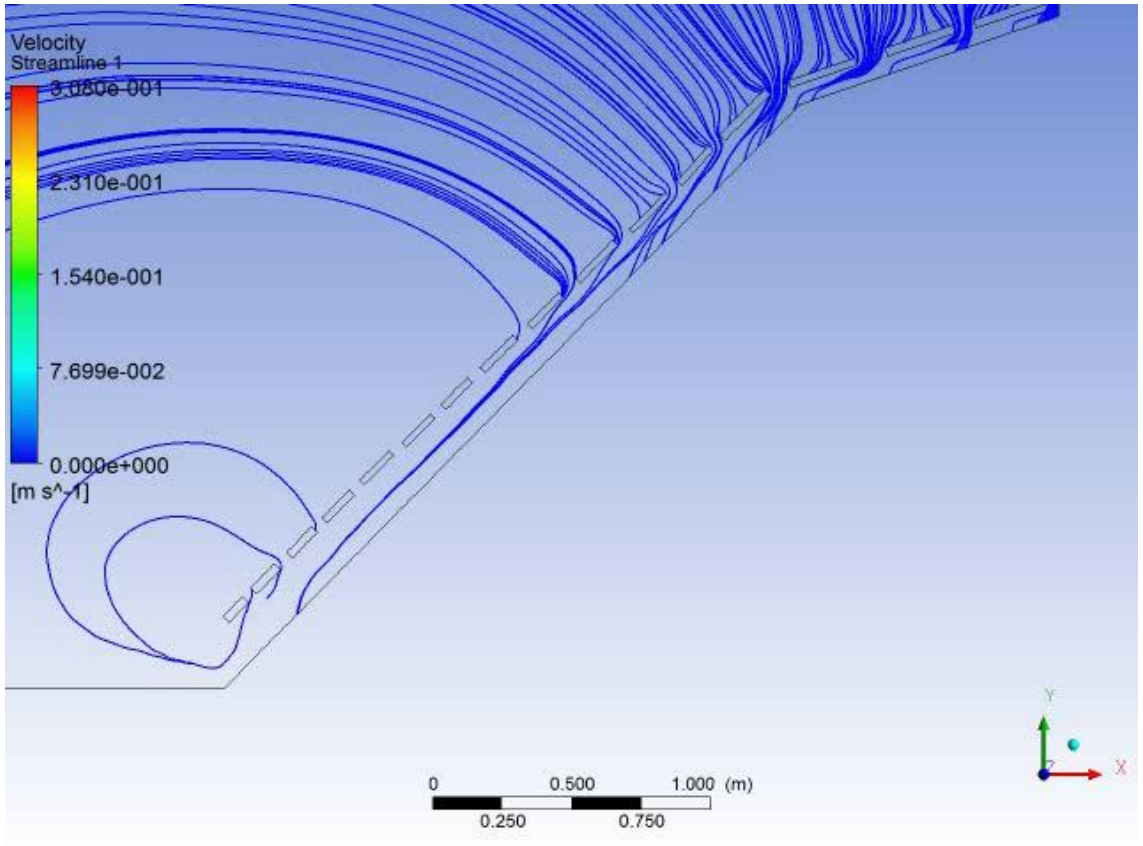
- Shelter Performance Database
  - Input parameters to perform energy audit to identify loss/gain and establish parameters for ECU
  - Locations, shelter manufacturers, shelter models, shelter liner & fly
  - Reconfigured to import, sort and store test data & new tables for each test parameter constructed





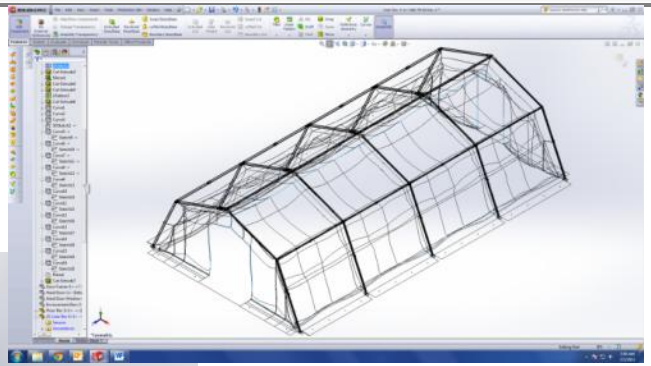
Technology Accomplishments: Modeling & Simulation

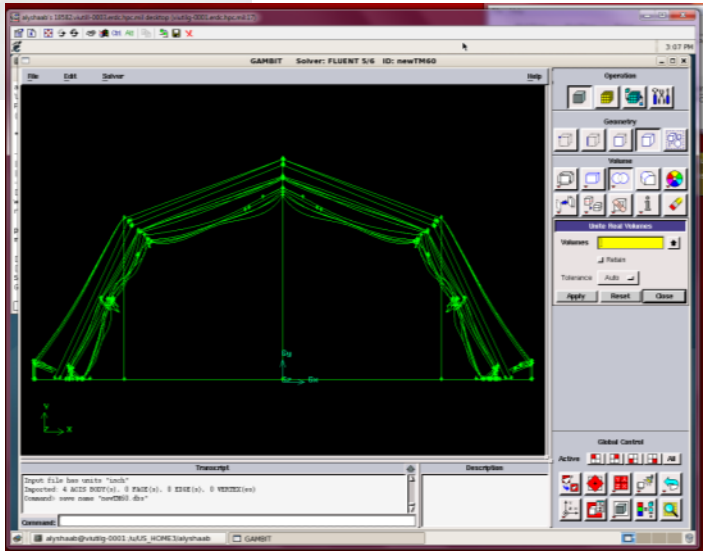
- 2-D numerical model
  - Validated using different boundary conditions
  - Used to analyze airflow dynamics around a perforated shelter fly



Technology Accomplishments: Modeling & Simulation

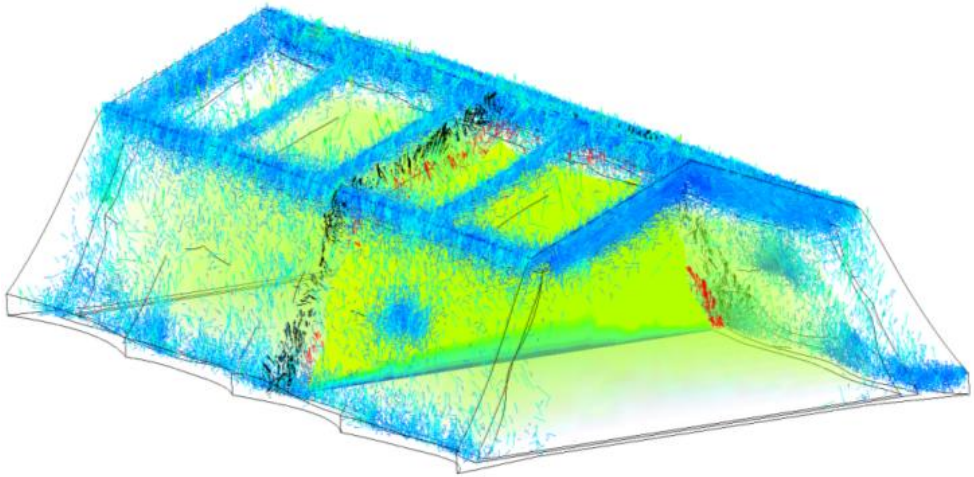
- Version-I 3D-CAD Model: Excludes shelter fabric curvatures
- Version-II 3D-CAD Model: Includes fabric curvature and form
  - Challenged by shelter envelope thin layers' thickness, fly's sharp droop
- Version-III 3D-CAD Model: Preliminary & enhanced grid mesh generated
  - Boundary condition developed from Net Zero Ft. Irwin data

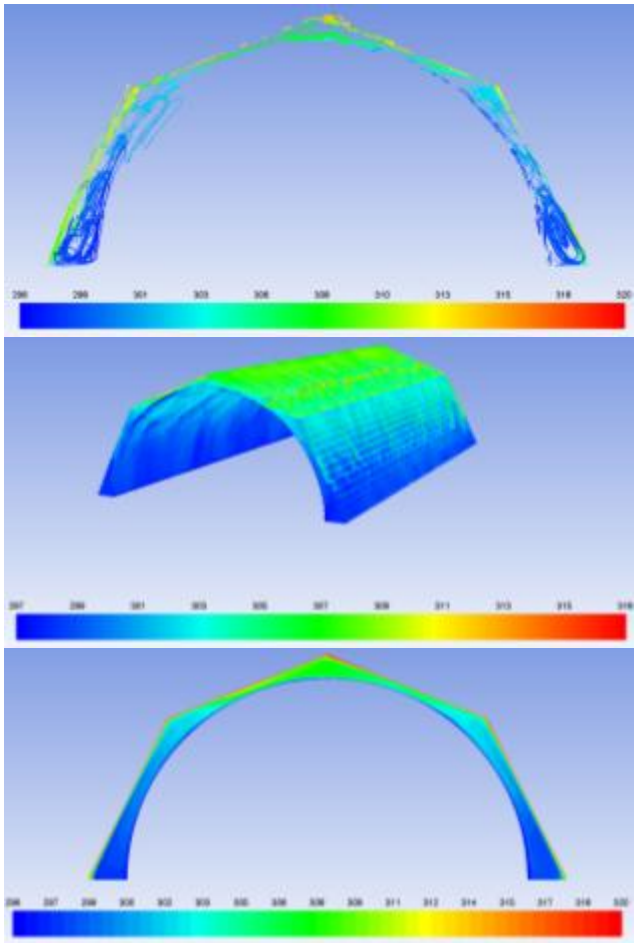




Technology Accomplishments: Modeling & Simulation

- Computational Fluid Dynamic Analysis: Applying boundary condition data to explore regimes and buoyancy driven convection inside air gaps





Follow-On Demonstrations

Objective: Build on and leverage the lessons learned in the Initial Demonstrations by incorporating the Technology Development accomplishments into optimized shelter systems further reducing fuel consumption.

Next Steps: Shelter design workshop & coordinate next demonstration locations

- Most advanced and effective shelter system to include solar barrier, thermal insulation, environmental control unit and accessories
- Demonstrated and validated performance in a field environment

50% Reduction in Power Consumption
Improved Capabilities
Technology Transition

Net Present Value = $3.1B
Savings to Investment Ratio = 15.3:1

JOCOTAS S&T Coordination

- Energy Technologies
  - Thermal Modeling & Simulation
  - Insulation
  - Lighting: LEDs, Solar Day Lighting
  - Renewable Energy: Wind, Solar, Combined Heat & Power
  - Waste to Energy
- Operational Energy Capability Improvement Fund
  - Super CLU, Innovative Cooling Equipment, Energy Modeling,
- How can we best collaborate S&T efforts?
  - Shared web space: APAN, Sharepoint, AKO/DKO
  - Newsletters
  - Meetings

Summary Discussion

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