Establishing a High Throughput Heterogeneous Network 24/7 in Remote Areas with Unimproved Road Conditions with ThinSat®300
Affordable OpEx Solutions for Low-Profile Satellite Communication-on-the-Move (COTM)

Background:
ThinKom characterized capability and quality of service for on-the-move SATCOM off-road network capability of the ThinSat®300 Satellite-on-the-Move (SOTM) system at a recent Joint Interagency Field Exploration (JIFX) demonstration. The 4” Phased Array Satellite Antenna, with minimal profile, has been proven to support operation in a number of challenging government applications. Forward Field-Ops and ISR conditions were simulated in a variety of terrain within Camp Roberts, while transmitting real-time video feedback by external camera and videoconferencing equipment. The test site had poorly maintained paved roads, dirt roads (flat and highly corrugated), unimproved roads (rocks larger than 4” diameter), and open prairie grassland.

Ad-Hoc Experiment Descriptions:
1) A multi-comms (terrestrial + satellite) network, composed of LTE, Mesh Network nodes (Parallel Wireless), TV Whitespace omni-antennas (Carlson Wireless), a stationary SATCOM link (IP Access), and a Mobile SATCOM link (ThinKom, with satellite network by IP Access). Video conferencing was demonstrated across the heterogeneous ad-hoc network.
2) A Mobile LTE node (Parallel Wireless) within the ThinKom SOTM vehicle, allowing for a mobile hotspot with SATCOM backhaul connectivity to the internet.
3) Characterize ThinSAT300’s Low-Observable signal and Anti-Jam capability with JVAB.

Primary Experiment: Off-road capabilities of ThinSAT300 for SOTM in Rugged Terrain

Use Case: In remote areas, military or government users have 24/7/anywhere satellite communications coverage on mobile platforms eliminating deployment time. Mobile satellite link can be used to backhaul local terrestrial networks.
Working Hypothesis: Mobile communications have been explored for terrestrial systems, but usage scenarios for mobile satellite communications have not been postulated in-depth. Once stationary requirements are eliminated, it can allow for a variety of usage scenarios in remote areas.
Objective: Allows for communications and high-speed data to be sent anywhere SATCOM coverage is available, in a number of rugged terrain conditions, while constantly moving to the next destination. Video conferencing from remote locations where no terrestrial connectivity exists.
Results: Satellite Link Performance over all rugged terrain conditions tested was accomplished. (Upper limits of tracking potential were limited by passenger discomfort from excessive vehicle movement over rugged terrain.)
- Poorly Maintained Paved Roads (12” potholes)- no SATCOM QoS issues at 50mph (passenger endurance level)
- Dirt Roads, (corrugated for high vibration)- no SATCOM QoS issues at 40mph (passenger endurance level)
- Non-Maintained Roads (4”+ diameter rocks, sand, ill-defined)- no SATCOM QoS issues at 25mph (passenger endurance level)
- Open Prairie (no road path, large sinkholes)- no SATCOM QoS issues at 25mph (passenger endurance level)
- Open Highway (well maintained)- no SATCOM QoS issues at 80mph+
ThinSat®300 Satellite-on-the-Move Antenna- the white “surfboard” on top of the vehicle.

ThinSat®300 next to IP Access’s pop-up dish- both satellite antennas operate on the same network.

Video Links to Actual Operation: [http://www.youtube.com/watch?v=Ya-HQ0ENaSQ](http://www.youtube.com/watch?v=Ya-HQ0ENaSQ)

Ad-Hoc Experiments

1) Multicom (Terrestrial + Satellite Network) used for Video Conferencing

Deployed in 45 minutes, this network was successfully deployed. Videoconferencing was used as a stress-test to measure packet loss, and time delay. The signal propagated thru as follows:

1) Videoconference participant #1 was located with the ThinKom mobile satellite link car. The car was uplinking to 83W, a satellite location over the East Coast.

2) The signal downloaded to a NOC on the East coast, went thru the internet to a separate NOC on the West coast, and then back up to another satellite 123W, to relay down to the IP Access 1.2m pop-up satellite dish.
3) A TV Whitespace antenna by Carlson was mounted to the Humvee, relaying the satellite signal terrestrially to MacMillan Airfield.

4) The signal was received and relayed at MacMillan airfield via Parallel's Wireless's 4G / LTE Mesh Nodes. The signal propagated thru a couple nodes, and was relayed to Videoconference participant #2 via LTE to their cell phone.

**Benefits of Each Network Element:**
- **Parallel Wireless**
  Self-provisioning macro-cell capacity LM LTE network with built in uniRAN mesh radio network with LTE and WiFi access.
- **Carlson Wireless radios**
  RuralConnect establishes an IP link on unlicensed spectrum using vacant wideband UHF TV white space (TVWS) channels and a omni antenna.
- **IP Access, International**
  A global satellite provider delivering high-speed satellite services for secure voice, video and data transmission. IP Access owns and operates the ISIS Network™, a multiple satellite network consisting of two teleport locations and hubs for complete redundancy of communication.
- **ThinKom Solutions**
  ThinSat®300, based on a phased array antenna technology operating at Ku-Band, VICST's broadband, low profile, antenna steers 360° in azimuth and 90° in elevation. Continuous satellite tracking while vehicle is in motion in rugged terrain provides IP, video and other satellite data streaming.

**Frequencies and attributes:**
- **Access frequencies (Parallel Wireless)**
  Multi-band capability including 700 MHZ Band 13 LTE broadband voice/data. Range: 1 km.
- **WiFi for alternate broadband voice and data access. Range: 100 meter.**
- **Backhaul frequencies (Parallel Wireless)**
  Mesh backhaul from uniRan base station at EOC to remote nodes on McMillan Field. Range: 2 km.
- **Local backhaul (Carlson Wireless)**
  TV white space (TVWS) on channel 21. EOC’s TV antenna beamed to 1 meter omni antenna on hill overlooking airfield. Range: up to 16 km non line of sight.
- **Long distance backhaul (IP Access)**
  ISIS Network™ satellite components: SES AMC 9 @ 83 East with hub in Woodbine, MD teleport. Intelsat Galaxy 18 @ 123 West with hub in Napa, CA with interoperability between sites and IP address switching capability.

Detailed Network Schematic Demonstrated at Camp Roberts
2) Mobile LTE node with SATCOM on-the-Move Backhaul
ThinKom (using IP Access’s satellite network) coupled Parallel’s wireless’s 4g / LTE node to the test vehicle, and tested to success this combination. This allows for passenger within a moving car, and other cars within the vicinity (such as a convoy) to have LTE access from their mobile devices, with ThinSAT300 providing the satellite backhaul connectivity to anchor the network.

3) VICTS Satellite Antenna Detection and Anti-Jamming capabilities, tested by JVAB
ThinSAT300 is based upon the VICTS Phased Array Antenna technology. Unlike other phased array antennas, that require thousands of phase shifter elements which in turn typically associated these antennas with million-dollar radar systems, VICTS scans it’s satellite beam electronically via a simply mechanical rotation. This low-profile nature of the system, and it’s in inherent capabilities to isolate other polarizations, lends itself to Low- Observable characteristics. JVAB detection was difficult until approximately 400m away while operating at 40W RF output power.

About ThinKom Solutions, Inc
Founded in 2000, ThinKom, is a leading provider of innovative highly-affordable compact broadband antenna and product solutions for aeronautical, on-the-move (OTM), and manportable applications. Its primary products uniquely enable near-term worldwide availability of affordable high data rate connectivity in the X-, Ku-, Ka-, and Q-Band frequency bands for the consumer, enterprise, first-responder, civil, military, and intelligence communities. For more information about ThinKom, please visit the ThinKom website at http://www.thinkom.com.