

# Satellite Communications Networks

Technologies and Best Practices for Minimizing EMI/RFI

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# Overall Industry Experience with Managing EMI/RFI



- » Designing and operating satellites and network systems to support more than a million users on a single network
- » Providing service for more than 650,000 customers
- » Hundreds of thousands: terminals, modems, other SATCOM hardware deployed in DoD
- » Global satellite service offering crossing multiple satellites and teleports



Satellites & Payloads



Network Infrastructure



24/7 NOC



Antenna Gateways



UHF to Ka Modems



Mobile/Portable Antennas

# Electro Magnetic Interference Understanding the Problem

- » Primary causes of Electro Magnetic Interference / Radio Frequency Interference (EMI/RFI)
  - › Poorly pointed antennas
  - › Rogue carriers
    - › Often time this is unintentional
- » Challenges in resolving EMI
  - › Arms length relationship between user, service provider and satellite operator
    - › Often takes weeks to months to resolve
  - › No industry set procedures to resolve once identified
    - › Often requires a 1-by-1 check of each remote
  - › Hard to identify EMI *before* it is a problem

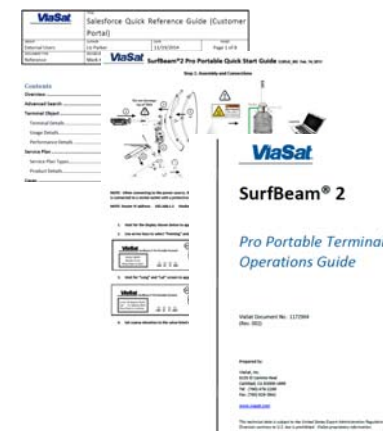


3.9m VSAT



60cm VSAT

## Training and Education



# Managing EMI/RFI

## Critical to Network Operations

- » Why is this important?
  - › Cost of capacity
    - › Badly pointed antenna cost ~5x the resources as a properly pointed one
  - › Terminal speed and performance
  - › User satisfaction / mission success
  - › Adjacent satellite interference
- » Our challenge
  - › 3,000 installers, setting up about 1,000 terminals a day
  - › About 70% annual turnover in installers
    - › Installer quality (typically “cable TV guys”)
  - › Installation time (1-4 hours)
- » Alignment of objectives:

### Objectives for Business

- Improve Installation Accuracy
  - Correct lack of valid forward link (downstream) reference for signal quality
  - Allow for installation assessment regardless of weather

### Objectives for Users (Installers)

- Simplify Training
  - Categories instead of Metrics
- Make Issues easier to Understand and Correct
  - Report failure and suggestion for how to fix it

# Managing EMI/RFI

## Critical to Network Operations

» What problems are we trying to solve?

Real Examples

### Improve Installs

- 11% of Installs are Performing Below Target (5000 kSym/s)
- 4% are severely impaired (1250 kSym/s)
- 7% are impaired (2500 kSym/s)
- Reduces capacity (less subscribers) and availability (performance)

### Improve Support

- 80%/50% of Modem/RF returns have no fault found
- Up to 7% of *Completed* Service Calls still require one

### Improve Technology Improvement

- Are installers trained with latest troubleshooting information
- Do tools evolve rapidly based on lessons learned



How do we approach solving these problems

System approach to network design

Tools

Training

# Managing EMI/RFI Network System Approach

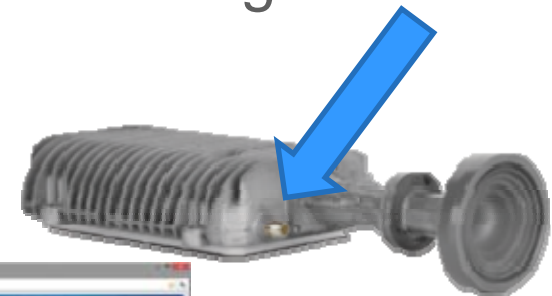
- » Holistic approach to end-to-end service
  - › Additional capabilities can be implemented
  - › Capability / Price / Performance trade-offs can be made
  - › Tools can provide greater insight



VS



Single IFL Cable



Network Visibility



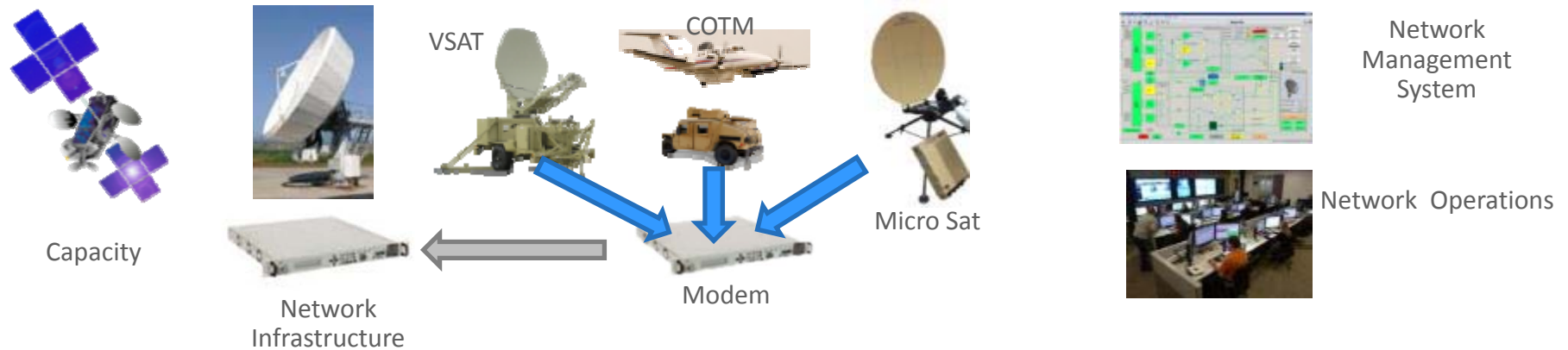
Local Visibility



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<http://www.geeky-gadgets.com/tesla-model-s-get-a-titanium-shield-to-prevent-fires-31-03-2014/>

# Managing EMI/RFI Network System Approach

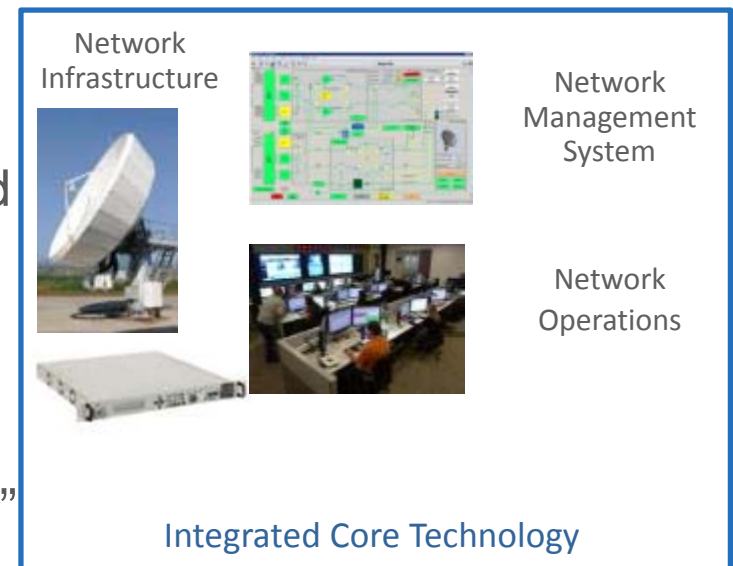
- » DoD Challenge: Decentralization of Services
- » Who procures what, who is responsible for problems?



- DoD is likely to continue some level of decentralized capacity procurement for the near future
- Emphasis can be placed on core underlying technology:
  - Network Infrastructure, NMS, Modem Technology
- Common core allows for better user experience and management tools

# Managing EMI/RFI Network System Approach

- » Common core allows for better user experience and management tools
  - › Provides understanding of what is expected performance
    - › May be easy today with SCPC networks
    - › Nearly impossible for most MF-TDMA networks
  - › Metrics to determine what “poor performing” means
  - › Allows consistent approach to resolve problems
- » Allows flexibility for a variety of terminals based on different CONOPS
  - › Modem-Network feedback loop is critical to successful network operations





# Managing EMI/RFI Tools

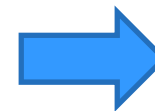
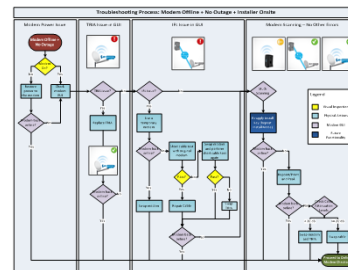
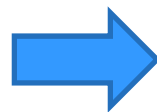
- » Modem GUI
  - › Provides local system *information*
    - › Signal Level (dB)
    - › Software Build
    - › Online Status
    - › Basic Diagnostics (temperature, attenuation, alarms, etc)
  - › Analysis requires experience / knowledge
- » Service Visibility Tool (portal)
  - › Provides *intelligence* about remote and network
    - › Signal Quality (how it relates to peers)
    - › Software Version (is it current)
    - › Connection to Gateway
    - › Connection to Internet
    - › Packet Loss
    - › Congestion and Outages
    - › Is Intervention Needed?
  - › Tool performs analysis



# Managing EMI/RFI Tools

- » Poor Performing Install List
  - › Real-time list of poor performing terminals
    - › Allows team to proactively address issues
    - › Information on how system performance is degrading
      - Over time or abrupt change
    - › Facilitates tracking of different installer groups
      - Is retraining required?
- » Continuous Improvement
  - › Today
    - › Metrics based approach
  - › Tomorrow
    - › Simplify message format
    - › Indicate category of failure
    - › Show both current and expected values
    - › Provide resolution steps based on decision tree algorithm

ID	Name	Status	Date	Score
22324		No	06/03/2014 10:00:00	100
22325		No	06/03/2014 10:00:00	100
22326		No	06/03/2014 10:00:00	100
22344		No	06/03/2014 10:00:00	100
22350		No	06/03/2014 10:00:00	100
22475		No	06/03/2014 10:00:00	100
22480		No	06/03/2014 10:00:00	100
22481		No	06/03/2014 10:00:00	100
22482		No	06/03/2014 10:00:00	100
22483		No	06/03/2014 10:00:00	100
22484		No	06/03/2014 10:00:00	100
22485		No	06/03/2014 10:00:00	100
22486		No	06/03/2014 10:00:00	100
22487		No	06/03/2014 10:00:00	100
22488		No	06/03/2014 10:00:00	100
22489		No	06/03/2014 10:00:00	100
22490		No	06/03/2014 10:00:00	100
22491		No	06/03/2014 10:00:00	100
22492		No	06/03/2014 10:00:00	100
22493		No	06/03/2014 10:00:00	100
22494		No	06/03/2014 10:00:00	100
22495		No	06/03/2014 10:00:00	100
22496		No	06/03/2014 10:00:00	100
22497		No	06/03/2014 10:00:00	100
22498		No	06/03/2014 10:00:00	100
22499		No	06/03/2014 10:00:00	100
22500		No	06/03/2014 10:00:00	100



# Managing EMI/RFI Training

Training cannot be the only way to reduce EMI/RFI ... but it can help

- » If network is understood, training becomes simpler
  - › Avoids training to “corner cases”
  - › Built in network tools allow terminal simplification
  - › Optimization can occur at network level instead of terminal level
- » Users are the first defense against miss-pointed terminals
- » Training Goals
  - › Consistent ability to get terminal on the network
  - › Limited knowledge of RF communications
  - › Short training time
- » How do we minimize the amount of effort and cost to train a user?



# Managing EMI/RFI Training

- » Web Portal Training
    - › Self-paced online courses and WebEx
      - › 18 modules of 10-30 minutes each
      - › Total training time ~8hrs
    - › Simplifies and reduces training on large scale
    - › Requires strong back end support for first time installs
  - » Computer Assisted Manual Point (CAMP)
    - › Allows consistent execution by a semi-trained operator
      - › Is an antenna controller more accurate than a user?
      - › Is a users more comfortable with a ACU or smartphone?
- Requires terminal / tool to have knowledge of the network



# Managing EMI/RFI Training

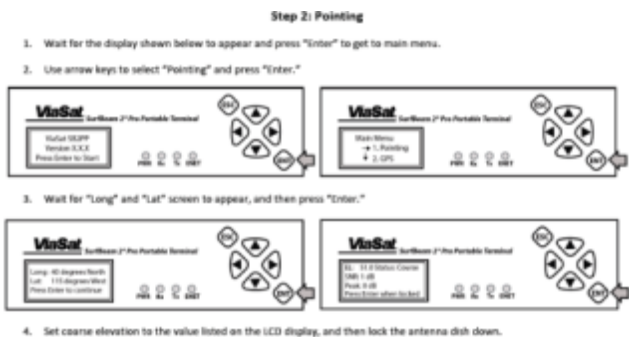
## » YouTube

- › Understand how your audience learns
- › Ideal for basic operator education
- › Will not work for sensitive systems / information

## » Quick Stat Guides

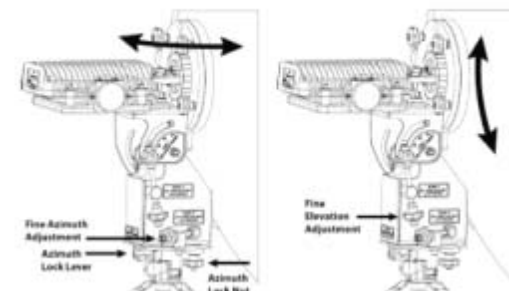
- › Must be “quick” (2-4 pages)
- › System must have sufficient marking to guide user

## » Can new users get a terminal online using only the training tools?



Step 1 ...

5. Fine tune azimuth using knob shown below until "Locked" appears in the Status display and the peak SWR equals the SWR value (target SWR = 2.0dB). Lock down azimuth and repeat procedure for fine tune elevation using the knobs shown below and press "Enter" to continue.



# Managing EMI/RFI

## Critical to Network Operations



- » How can EMI/RFI be successfully controlled:
- » Network system approach
  - › Common core architecture facilitates reporting and troubleshooting
  - › Allows establishment of “expected performance”
  - › Provides feedback loop between remotes and network
- » Tools
  - › Need intelligent tools to see how system is performing on the network
  - › Establish methodology for identifying poor performing terminals and actively resolving
- » Training
  - › Training becomes easier when network system approach is utilized
  - › Work to minimize training time while ensuring consistency