

Caltrans Office of Radio Communications CTSATCOM Program



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Overview

- What is CTSATCOM
- Overview of Satellite Communications
- Fixed Sites
- Mobile Trailers
 - Setup
 - components
- Compact Rapid Deployable
- Lessons learned
- Looking forward

What is CTSATCOM

- California Governor's Office of Emergency Services (CAL OES) developed a statewide non-terrestrial based communications systems known as the Operational Area Satellite Information Systems, or OASIS
- OASIS was a combination of fixed sites throughout 58 counties, and mobile trailers with the intent to provide key communication services in the event of an emergency situation
- OASIS was managed and funded by OES through grants
- In 2012, those grants were terminated and Caltrans saw a need to develop, own, operate and maintain their own satellite communications system, which became Caltrans Satellite Communications (CTSATCOM)
- Caltrans's Office of Radio Communications (ORC) manages the CTSATCOM program
- CTSATCOM sites are based on Very small Aperture Terminal (VSAT) satellite communications technology (1.2 to 3m diameter)

OASIS

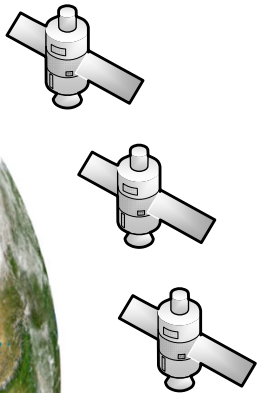
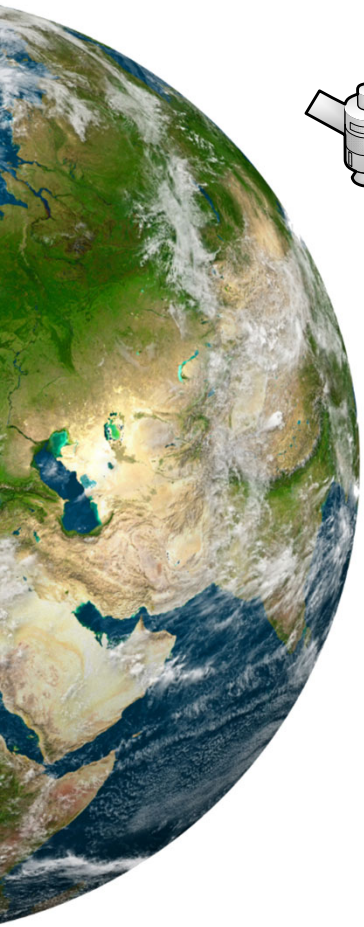
Interstate 580 Collapse



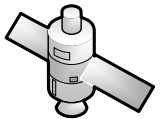
Satellite Communications Overview

- Satellite communications is the process of communicating using signals that bounce off extraterrestrial satellite
- Extraterrestrial – of or from outside the earth or its atmosphere
- Important during emergencies or natural disasters, when other communications infrastructure (i.e. cell towers, LAND Lines) may have been damaged, or are overloaded
- There are three main types of satellite Earth orbits; high Earth orbit, medium Earth orbit, and low Earth orbit
- New satellites are constantly being prepared to launch into space

Satellite Communications Overview



Low Earth Orbit (LEO)
(160-2000 Km = 99 – 1200 miles)



Geostationary Orbit (GEO)
(35,000 Km = 22,000 miles)

Because LEOs are much closer to the Earth when compared to GEOs, there is much less latency, which is vital for certain data and applications, as well as end-user satisfaction. There is less coverage per LEO satellite so they are often deployed in groups, known as satellite constellations to provide seamless coverage.

Satellite Communications Overview

	LEO(STARLINK)	GEOSTATIONARY
Distance From Earth/Frequency of operation	<ul style="list-style-type: none"> • 160-2000 Km = 99 – 1200 miles away from earth (almost 22 times closer to earth than Geostationary). • LEO (Low Earth Orbital) Satellite is smaller and less expensive. • One LEO satellite orbit takes between 90 minutes to a few hours around the earth. • Many LEO satellites strategically spaced and work together as a group (several hundreds to thousands – depends on Satellite communication providers) to create a constellation of LEO satellites orbiting around the earth and can provide complete global coverage. 	<ul style="list-style-type: none"> • 35,000 Km = 22,000 miles away from earth. • Geostationary satellite is larger and more expensive. • It is the earth-orbiting satellite directly above equator and revolves in the same direction with the earth (West to East). • One orbit takes 24hrs, the same as earth rotates on its axis. • It appears nearly stationary in the sky as seen by a ground based observer / satellite stations.
Latency (Time delay)	<ul style="list-style-type: none"> • Low Earth Orbit means less communication time travelling between two earth-based stations. • The latency is about 25 ms. 	<ul style="list-style-type: none"> • The large distance from Earth requires more communication time from A to B stations on Earth. • The latency is at least 600+ ms.
Advantages	<ul style="list-style-type: none"> • LEO satellite is at a lower orbit and far less impact by solar storms, EM interferences. • Consume less power to transmit, small footprint, easy to setup. helicopters, aircrafts. 	<ul style="list-style-type: none"> • No doppler shifts due since stationary at the position.

Fixed CTSATCOM Sites

- Provide emergency voice services
- Located at sites designated as Emergency Operation Centers (EOCs) and alternate EOCs, as specified by Caltrans OES
- Phone services are currently provided through conventional telephone units that connect to a Voice Gateway, and onto the Satellite network
- There are a number of sites that have no conventional form of internet service and in those cases, satellite service can be provided for both internet and phone services
- Advancements in satellite technology, such as those operating in the Low Earth Orbit (LEO) and service providers such as StarLink are being considered to provide voice and data to these sites
- Could provide less latency, more bandwidth, and stability.

Fixed CTSATCOM Sites

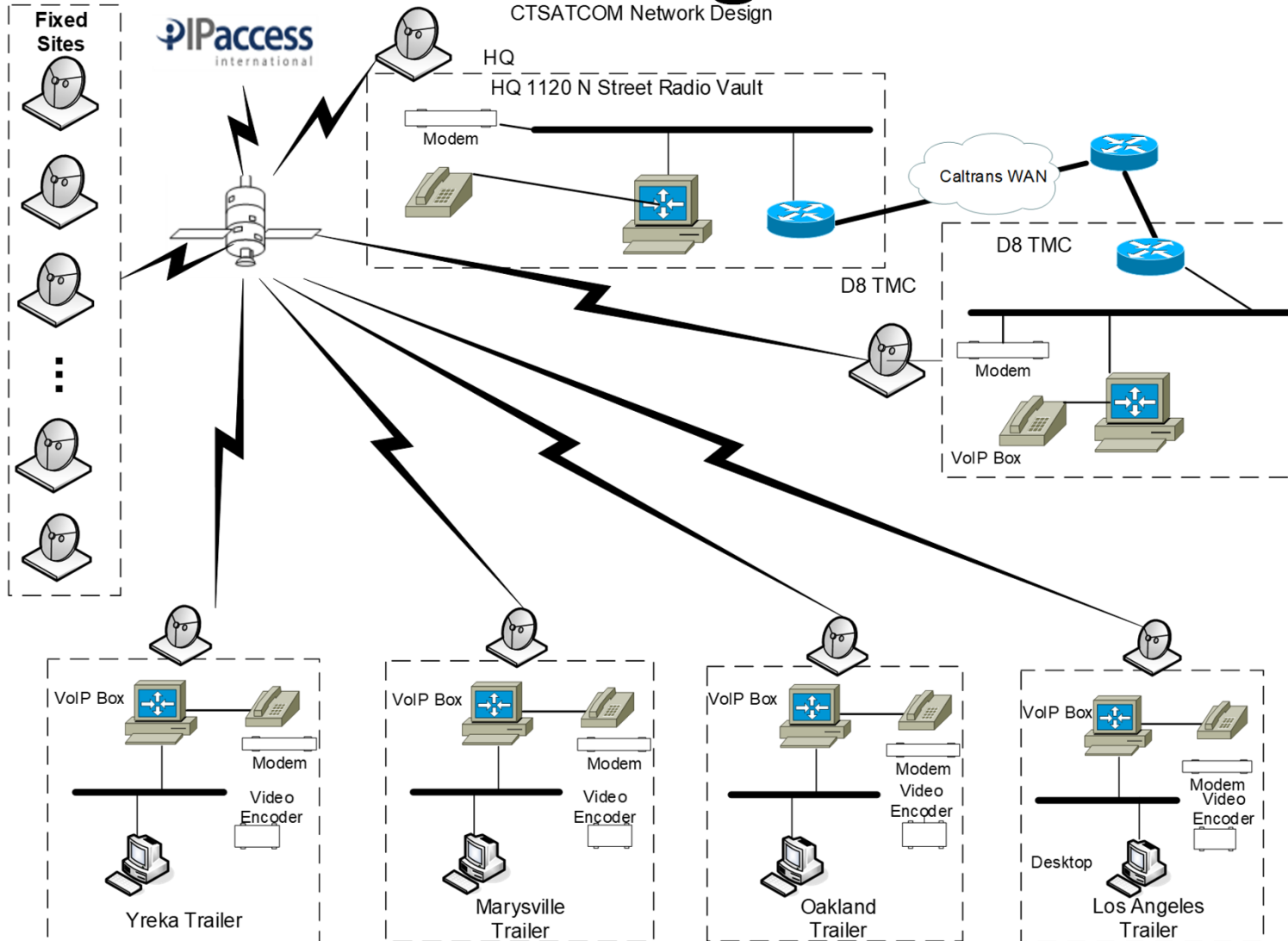


Mobile CTSATCOM Trailers

- Provide emergency voice, video and data services
- Currently there are 4 trailers located in Districts 1, 3, 4 and 7
- Each of the trailers can be deployed to any part of the state
- Services include:
 - 24 lines of VoIP telephone
 - Streaming video from Mast-mounted cameras
 - Internet data services
 - Limited 2-way radio service
 - 800 MHz Radio Repeater functionality
- Future upgrades:
 - Dish upgrade
 - 16 channel Radio Repeater with Phone patch
 - Video encoder to update to more modern video standards

CTSATCOM Design Overview

Fixed Site speeds:
 3Mbps upload
 1Mbps download



Mobile Site speeds:
 20Mbps upload
 5Mbps download

CTSATCOM Trailers Operations

- CTSATCOM Program is managed by Caltrans Special Projects group within the Office of Radio Communication, located in Sacramento, Ca.
- Telecommunications engineers design, install, maintain, and provide support of the communications equipment inside of the Trailers
- There is a Statewide Equipment Manager who oversees the deployment of the CTSATCOM trailers – **Geno Cervantes**
- There is a dedicated CTSATCOM trailer crew in each of the 4 districts that have trailers, who maintain, operate, and test the trailers.
- Transportation drivers for the trailers aren't necessarily dedicated
- Trailers are tested monthly to ensure functionality and identify any repair needs
- Can be requested by any district and office within Caltrans, as well as other state agencies
- Emergency incidents have an immediate deployment target, while non-emergency events suggest a request be made at least five days prior to event

CTSATCOM Trailers Deployment

- Mission request received from HQ.
- ORC and statewide Equipment Manager review request. Site trailer placement, What service(s) are being requested, video, command center, internet. Etc. Determine whether or not the mission task can be fulfilled
- Secure staff/vehicle (not dedicated) to tow trailer. Staff confirmed. Lodging secured, assessment of existing communications
- Staffing schedule worked out to support the deployment. Volunteer staff, their work is absorbed with the working crews. Work with volunteers, regarding last minute deployments
- About 60 minutes to get things up and running once on site. Trailer placement and turn procedures
- Trailer meant to provide long term communications support. Tear down is reverse of set up and takes about the same amount of time, prep trailer for next deployment, repairs, etc.. (top of propane tanks)

CTSATCOM Trailers Setup Overview

- Park trailer in a position where satellite has an unobstructed view to the SouthEast sky, where the Galaxy 18 Satellite is in orbit
- Turn on Propane
- Set circuit breakers
- Set switch to use the on-board generators for power
- Separate trailer from truck and level the trailer using the auto leveler
- Extend camera mast, ensuring there are no overhead obstructions (i.e. power lines)
- Connect Wavion antenna to mount on trailer roof and plug in ethernet connection
- Turn on Uninterruptible Power Supply (UPS)
- Power on comm equipment (controller, modem, switch, encoder, VoIP gateway, etc.)
- Use Satellite controller to have auto-acquire dish find and connect to Galaxy 18
- Once completed, the modem will indicate connectivity and now the trailer has satellite communications
- Place safety sign on ladder of trailer to prevent possible exposure to microwaves

CTSATCOM Trailers Setup Guide

CT Satellite Communications
 Trailer Start up Guide



Next is to level trailer. Release pintail hook – remove key.



Next locate the satellite controller and modem.



Be sure valve is turned on and the window shows green.



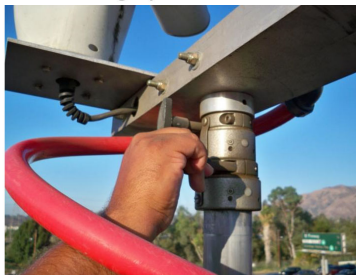
Go to back of trailer and start the leveling system POWER.



As dish deploys if it looks like it will hit trailer TURN OFF controller.



Open up side door of trailer and locate the circuit breakers.



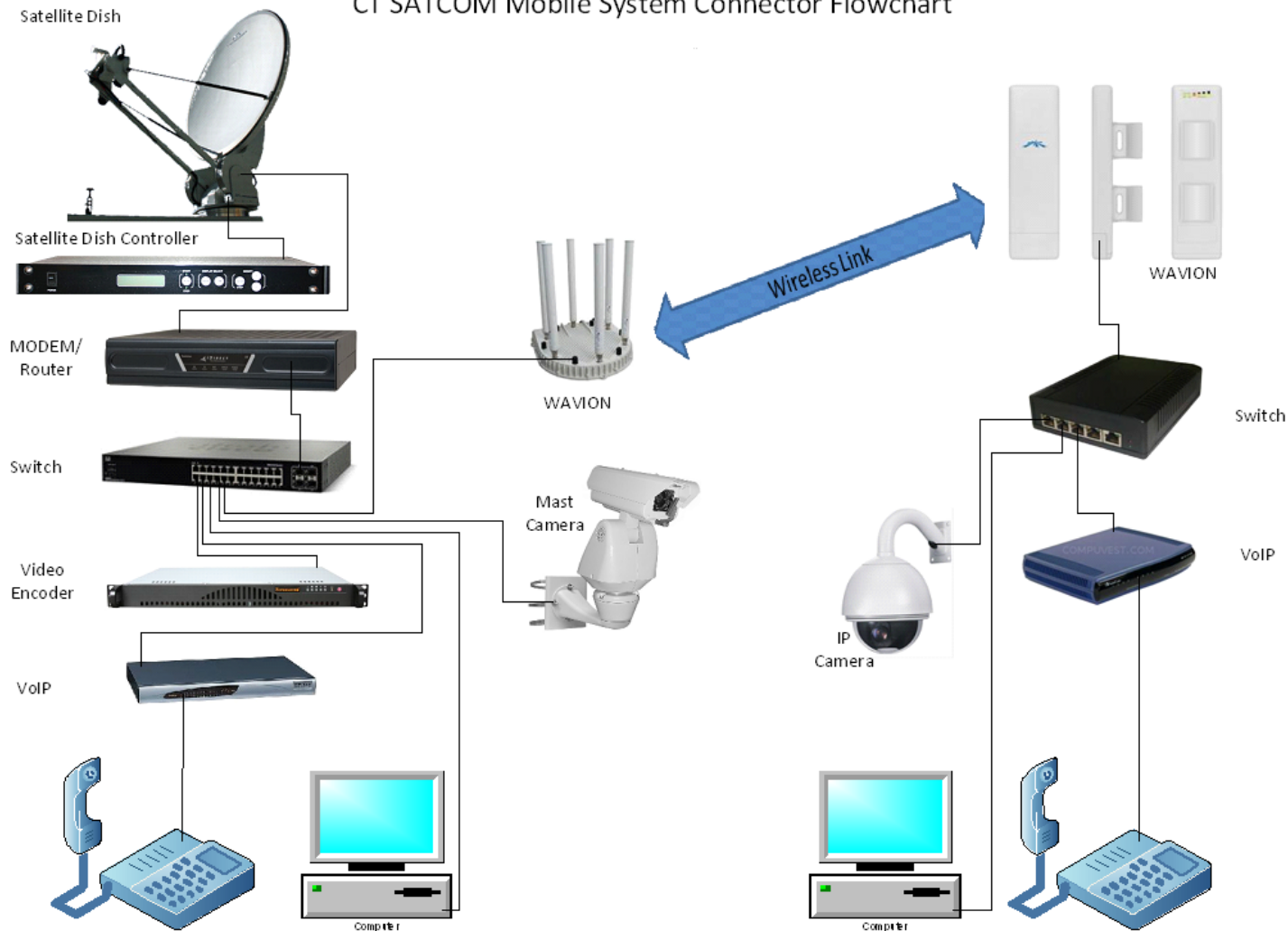
As each extension tube extends lock it down.



Place safety sign on ladder to prevent accidental exposure to microwaves.

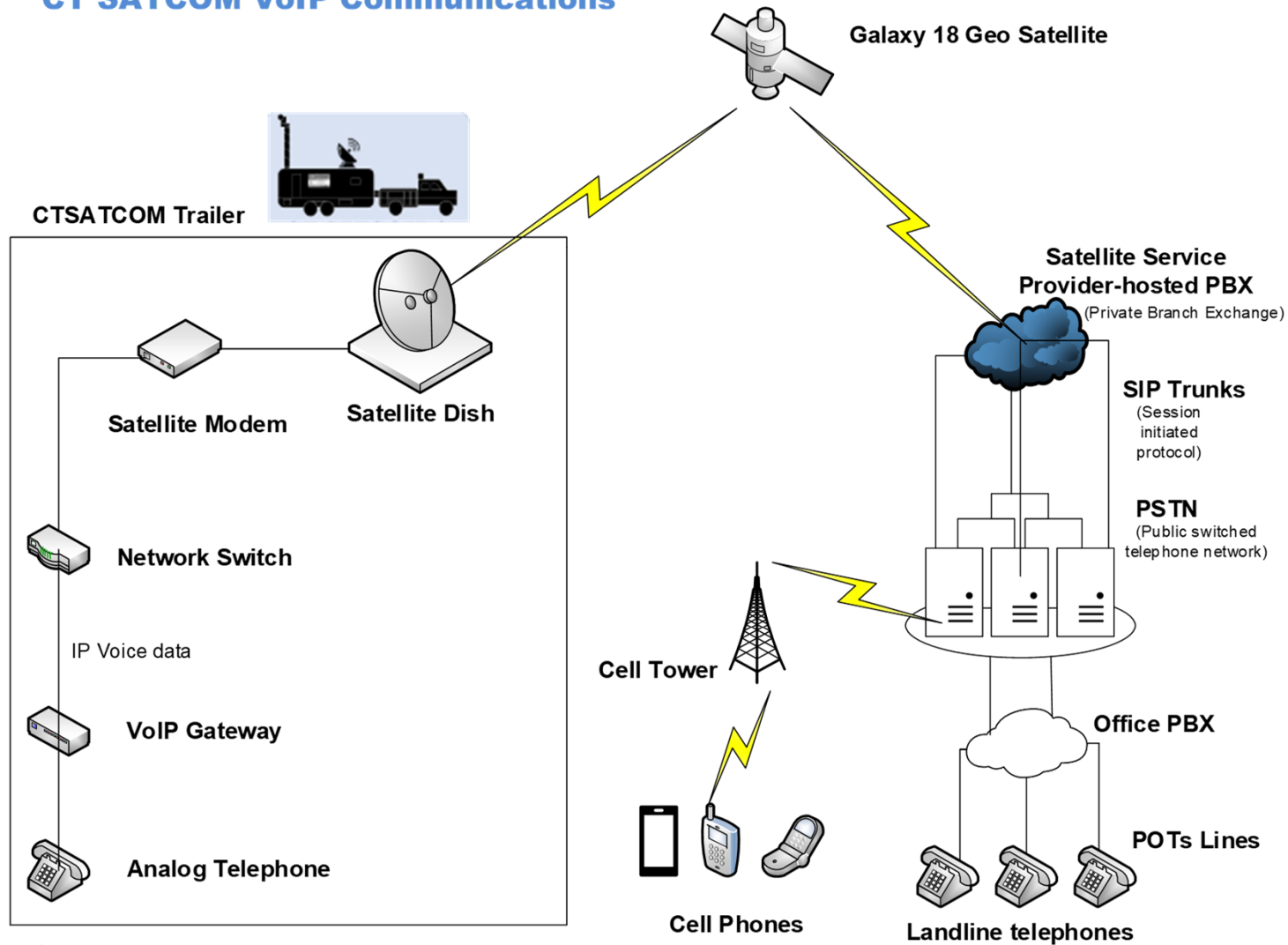
Mobile CTSATCOM Trailers

CT SATCOM Mobile System Connector Flowchart



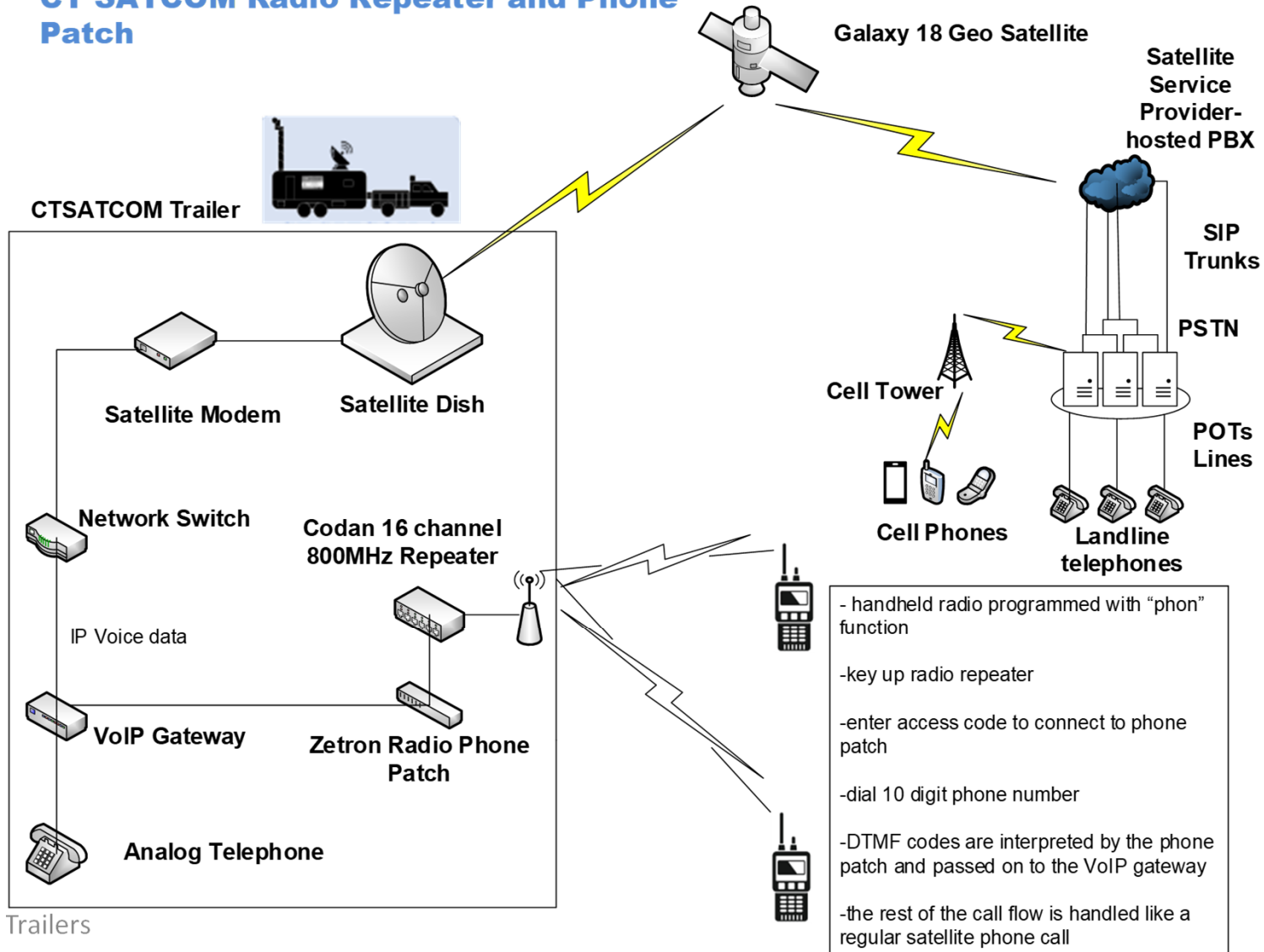
CTSATCOM VoIP Phone System

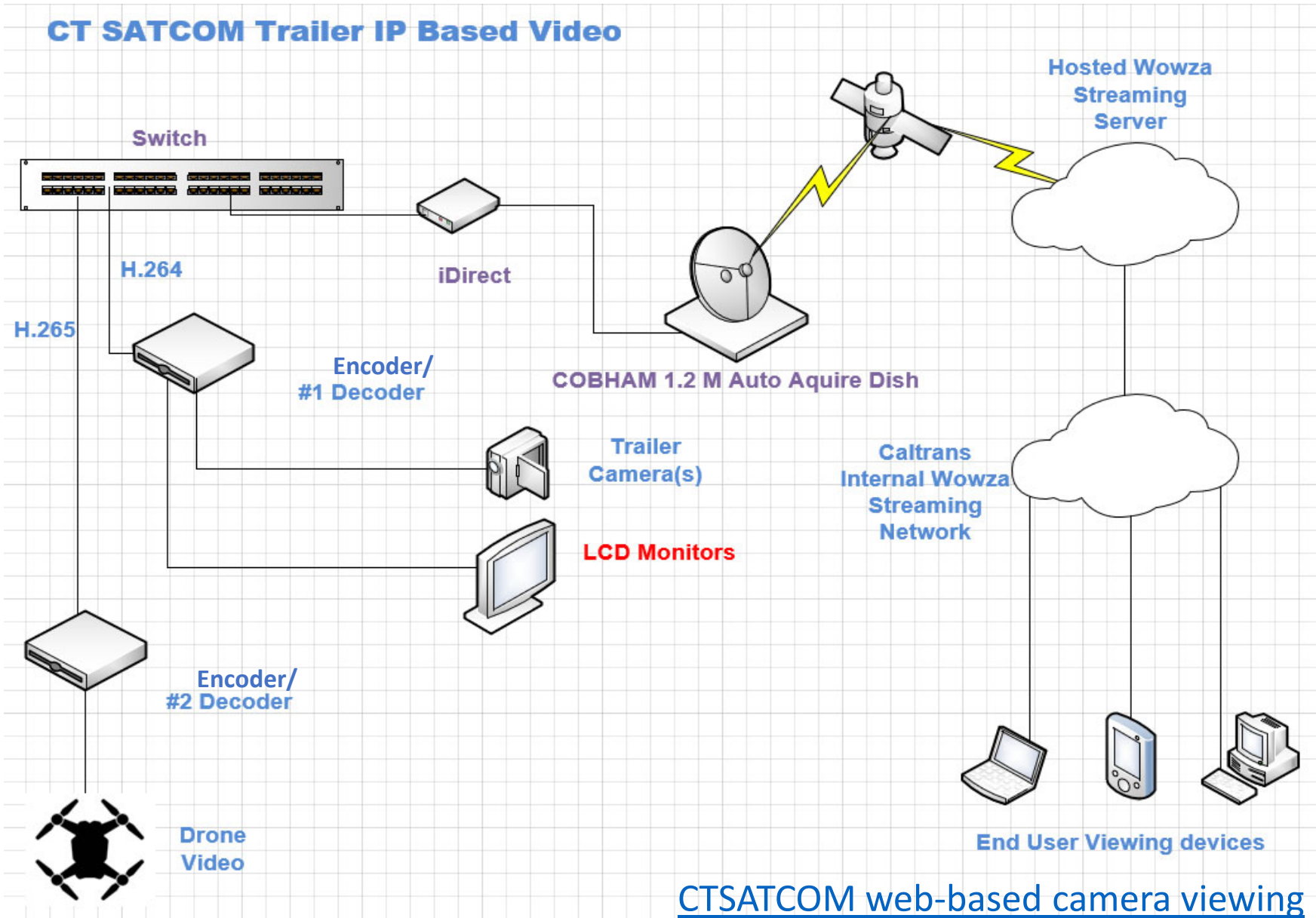
CT SATCOM VoIP Communications



CTSATCOM Radio Repeater & Phone Patch

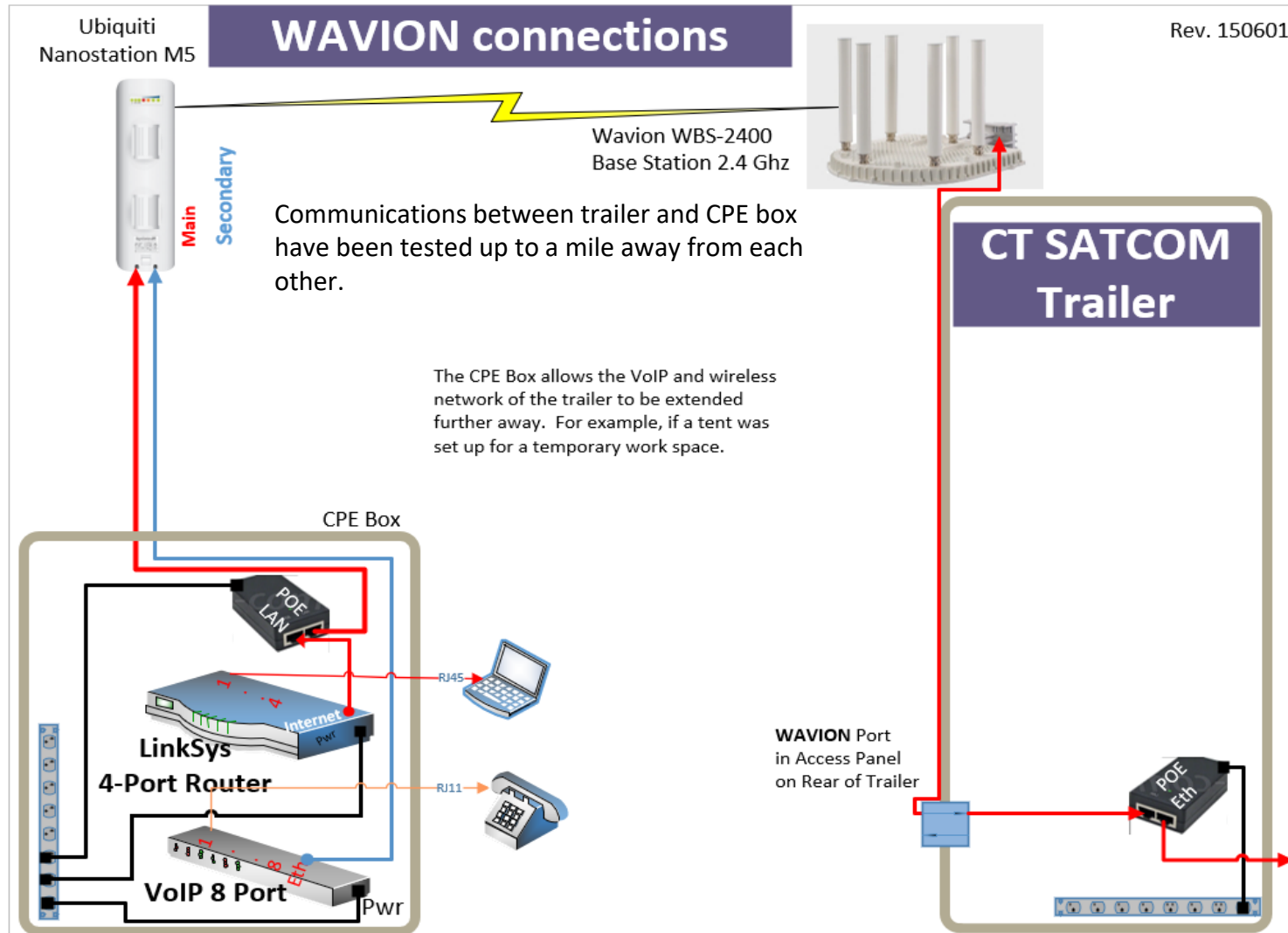
CT SATCOM Radio Repeater and Phone Patch





[CTSATCOM web-based camera viewing](#)

CTSATCOM Wavion Connection



Mobile CTSATCOM Trailer Deployments



CTSATCOM Trailers pictures



Mobile CTSATCOM Trailers

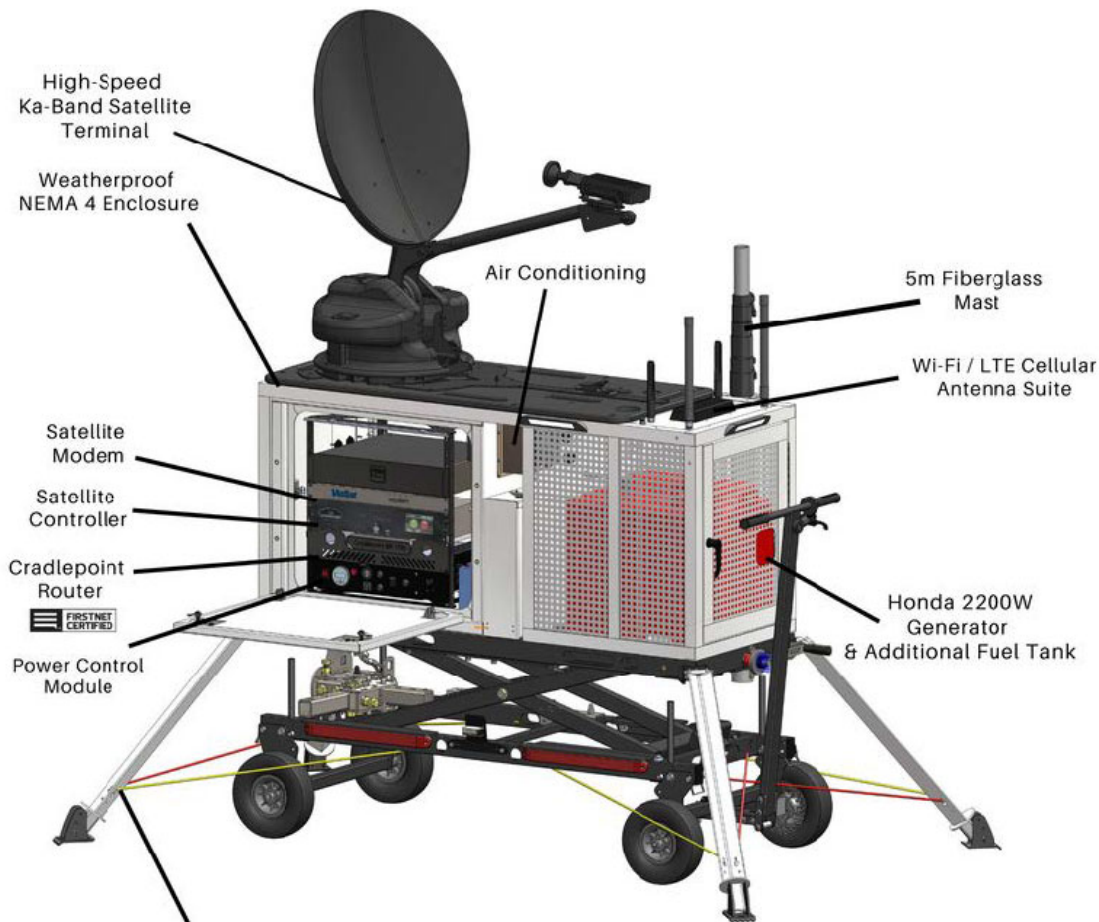


Mobile CTSATCOM Trailers



Compact Rapid Deployable (CRD)

- New mobile solution recently added to CTSATCOM

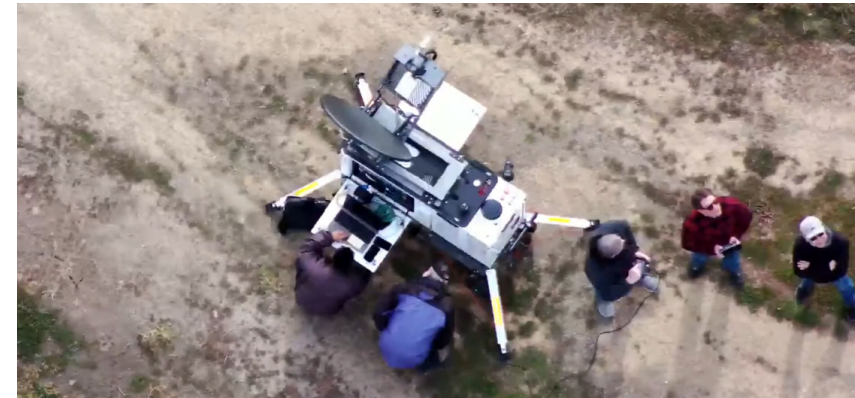


Compact Rapid Deployable

- Self-contained mobile communications solution
- Capable of providing satellite, cellular, wifi network, and VoIP communications
- Can handle SIM cards from multiple carriers, and also FirstNet
- Video encoder to connect drone controller
- More rapidly deployed

Compact Rapid Deployable (CRD)

- Similar to the Fixed CTSATCOM sites, we are currently investigating more recent technology to possibly include on the CRD to best serve our customers



Lessons Learned

- Demand for higher speed, higher bandwidth, and lower latency network connectivity is constantly increasing and our components need to keep up
- Advancements in satellite technology are providing more options for upgrading
- Certain deployment situations may not allow for a large trailer unit to be utilized, so a smaller form factor, such as the Compact Rapid Deployable (CRD) could be used
- Original IP addressing scheme is running out of IP addresses, as more devices are becoming IP-based
- Drone video is becoming a standard and we need to be able to provide method(s) to stream that video
- Custom-engineered solutions pose challenges when needing to be upgraded/replaced
- Documentation of system and equipment need to be improved

Looking Forward

- Looking to upgrade our communication equipment to provide the higher speeds needed for today's needs
- Exploring LEO satellite services
- Added CRD to suite and are continually adding to the functionality of it. Also looking into the mini CRD, which is a suitcase version that can provide satellite services
- Finding ways to incorporate Drone video feed into the trailer and live stream
- May need to restructure the IP addressing scheme of our satellite network
- Improve documentation of our systems to be able to better manage it
- Always listening to our customers to make sure our designs and upgrades are in line with what they need out in the field and during emergency responses

Thank you!





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