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BHEPP PROJECT: EMERGENCY WIRELESS EMAIL

Future Integration of BHEPP Research Initiatives

This graphic displays how it is hoped the 11 BHEPP research initiatives will work together in the future to ensure sustained communications and access to information during a disaster.

Explosions cause hundreds of casualties, cripple power grid, and degrade phone and internet communi-catlons in Bethesda

Patient triage data captured with digital pen 1

RFID tag put on patient; patients will be tracked in both hospitals 3

Patient arrives to Walter Reed NMMC

9 Patient medication data obtained from SureScripts®

Patient's spouse checks 'Lost Person Finder' website and learns patient was transferred to Suburban Hospital 8

Hospital personnel trained via Virtual World training participate in response 11

Patient transferred to Suburban – voice repot made from WRNMMC radio to Suburban cell phone via wireless bridge 7

Suburban personnel need information on new drug – Disaster Information Specialist acquires it 10

Patient data from National Naval Medical Center to Suburban via

4 Laser

5 Dark fiber

6 MARS radio

2 Patient Data Exchange (vehicle for data transfer between hospitals)

For more information: www.bhepp.org

Any nice day...

- A large winter storm knocks down power, and trigger a large blackout.
- Terrorists detonate a EMI bomb downtown that severely disrupts telecommunications and power regionally.
- Hackers disrupt large parts of our utilities infrastructure (electricity, telecoms, water supply, …)
- A large earthquake hits the East coast…

Any nice day...

Some potential consequences

- Surge in demand for hospital services
- Cell phones and Internet access fail
- Land line telephone service can be disrupted
- Staff and communications know-how can become scarce.
- …

The missing staff issue…

- Some studies suggest that 30% or more of hospital staff may not be available to work during a major disaster.
- Reestablishing communications require specialized expertise → a limited resource.
- How to improve chances of hospitals having communications support during a large disaster? → redundant communications support from community.

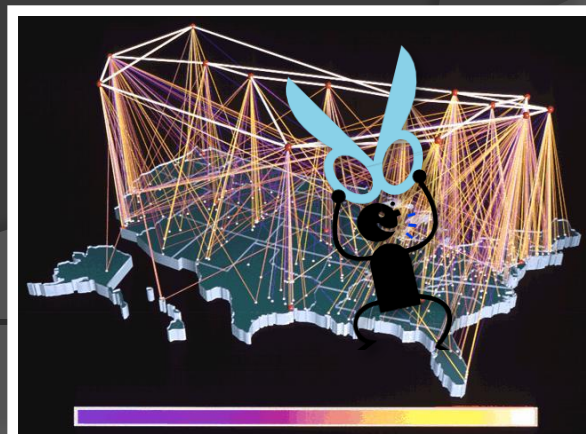
Emergency Communications Needs of Hospitals

- Hospitals need to contact other hospitals (e.g., for surge coordination)
- Emergency management authorities (Mo. Co. Office of Emergency Mgmt. and Homeland Security, law enforcement, F&R, ASPR EOC, Military, etc.)
- Suppliers
- External medical support (e.g., tele-consultation.)

…and increasingly via computer communications.

Wasn't the Internet built for resiliency?

- Yes, DoD-developed to resist nuclear attacks.
- Designed with redundancy and automatic reconfiguration.
- Failures are usually local or regional.
- Most commonly, failure is in "last-mile".
- Large outages happen: "Internet routing glich kicks millions offline" (↗) Nov 7, 2011, affected 7 states an international connections.
- Hackers have been able to knock down portions of the network.

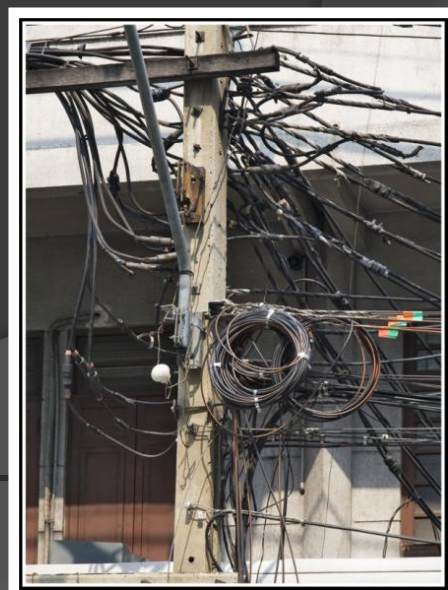


Aren't satellites always available?

- Yes and no
  - Expensive.
  - Depend on terrestrial infrastructure.
  - Can require specialized equipment and skills.
  - Can be affected by atmospheric, space, and "economic" weather.

Why is it difficult to remain connected?

- Services widely dependent on complex infrastructure.
- Many potential points of failure.
- Depend on multiple entities for maintenance and control.
- It's expensive to procure for high communications reliability.
- Technical support can be difficult to obtain during a disaster.



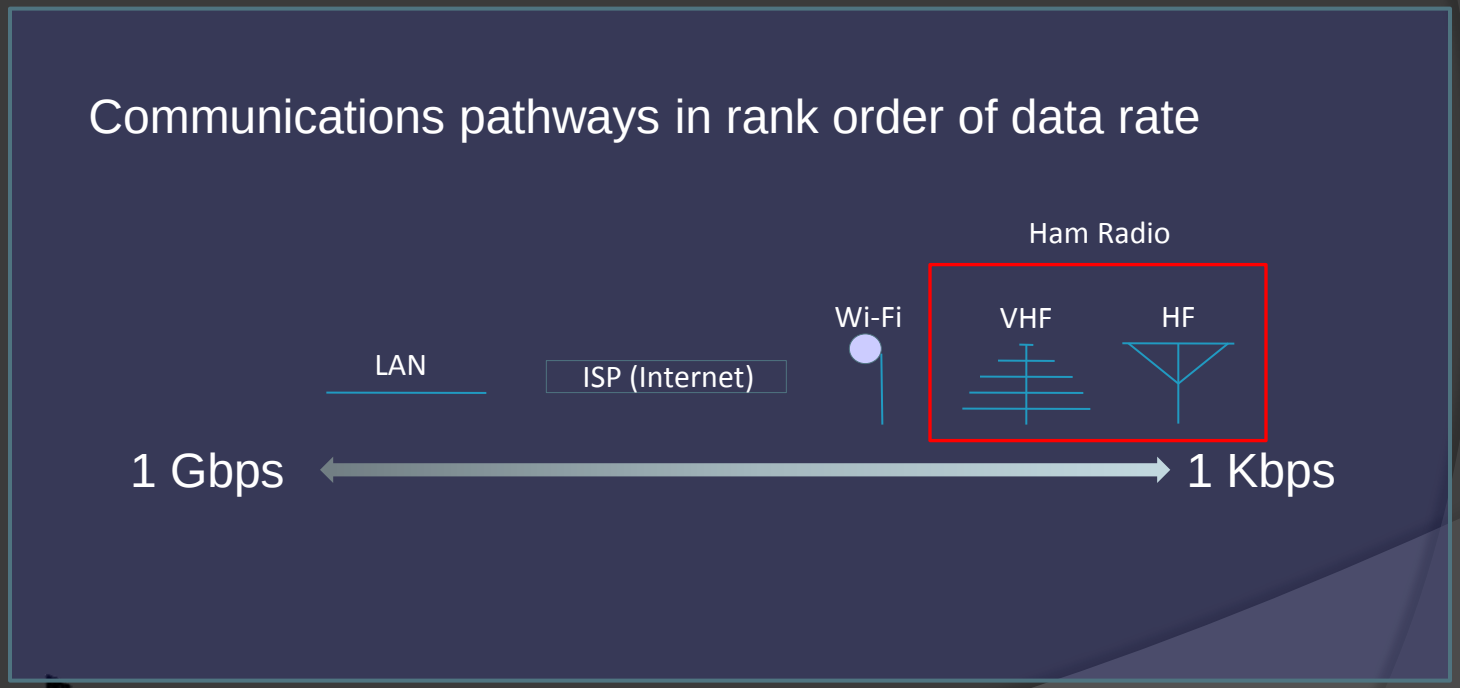
Another option

- Digital Amateur Radio technology.
- Pros:
  - Not critically dependent on local infrastructure.
  - Cheap, cheap, cheap.
  - Readily available.
  - Free technical support available from many “hams”.
  - Can be used for analog voice too.
- Cons:
  - Slow, slow, slow (due to legal bandwidth restrictions).
  - Still depends on electricity.
  - Requires expertise and (at least during non-emergencies) a license to operate.

Research Questions

- Can we leverage ham radio resources to provide last-resort communications to BHEPP?
- Can we use the ham radio technologies to communicate CRITICAL DATA beyond an Internet/phone communications blackout zone?

During Disasters, Speed is Less Important



Why digital ham radio?

- Analog voice over radio:
  - A single operator talks to one or more operators.
  - requires a counterpart listening at the other end while communication takes place (real time).
- Reality is:
  - Multiple EOC staff may need to communicate with multiple counterparts at the same time
  - a single radio transceiver for voice communications becomes a bottleneck.
  - Hospitals need to transfer accurate DATA.
- Digital services can store messages from multiple parties and retry until delivered automatically ("store & forward" technology).
- Internet email technology over radio can help.

+

Development Steps

- Investigated resources (existing solutions, potential contractors, etc.) and limitations.
- Collaborated with Radio Amateur community.
- Designed a potential architecture.
- Built a prototype.
- Performed field tests
  - Inter/operability
  - Reliability
  - Usability
  - Improved design and performed more tests
- Reviewed training needs (skill set).
- Built a sustainability model.

Some basic problems

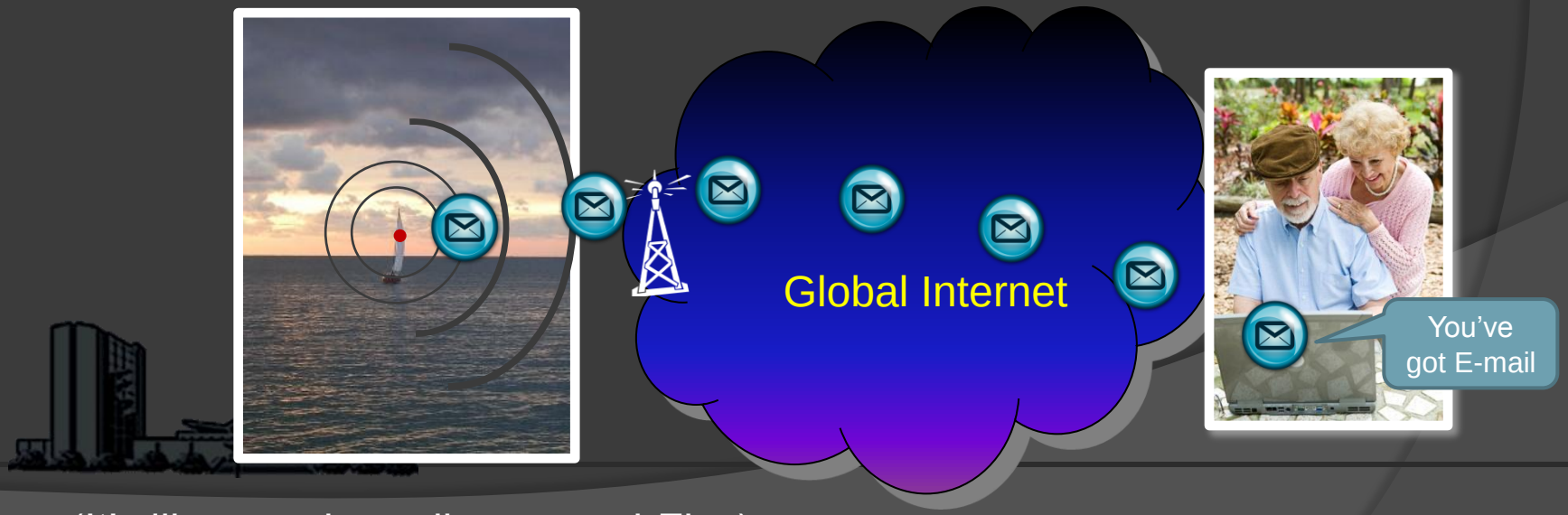
- Amateur radio practitioners are hobbyists.
- Regulations limit our “official” use of ham radio spectrum (FCC Part 97 rules).
- Ham radio resources sometimes over-utilized and under-maintained.

MARS to the rescue!

- We collaborated with the Army version of the Military Auxiliary Radio System (Army-MARS).
- Builds on amateur radio but is subjected to Military rules.
- Staff continuously train on emergency communications.
- Their mandate is to serve the military, the emergency community and the general public during emergencies.
- Have dedicated set of resources.
- MARS frequencies not subject to FCC restrictions.

Key Resource: The Winlink 2000 System (WL2K)

- Developed by hams.
- Enables free email by radio to/from the Internet.
- MANY dedicated radio stations relay email between radio users and Internet users.



(It's like very-long distance Wi-Fi…)

How does WL2K work?

Typical user configuration:

PC + email software

Antenna

Radio
Transceiver
+ Modem

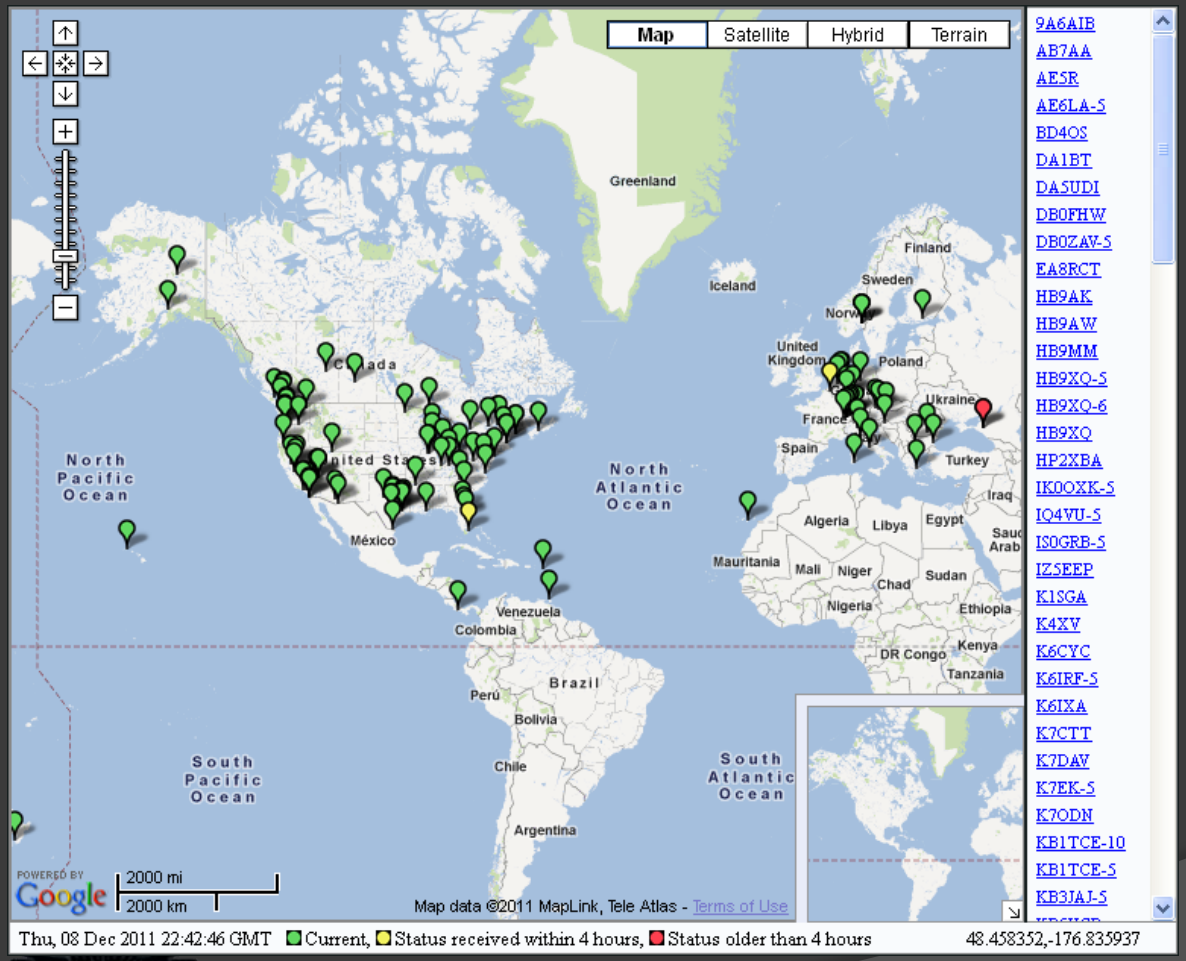
RMS
Stations

Global
Internet

Redundant
email
Servers

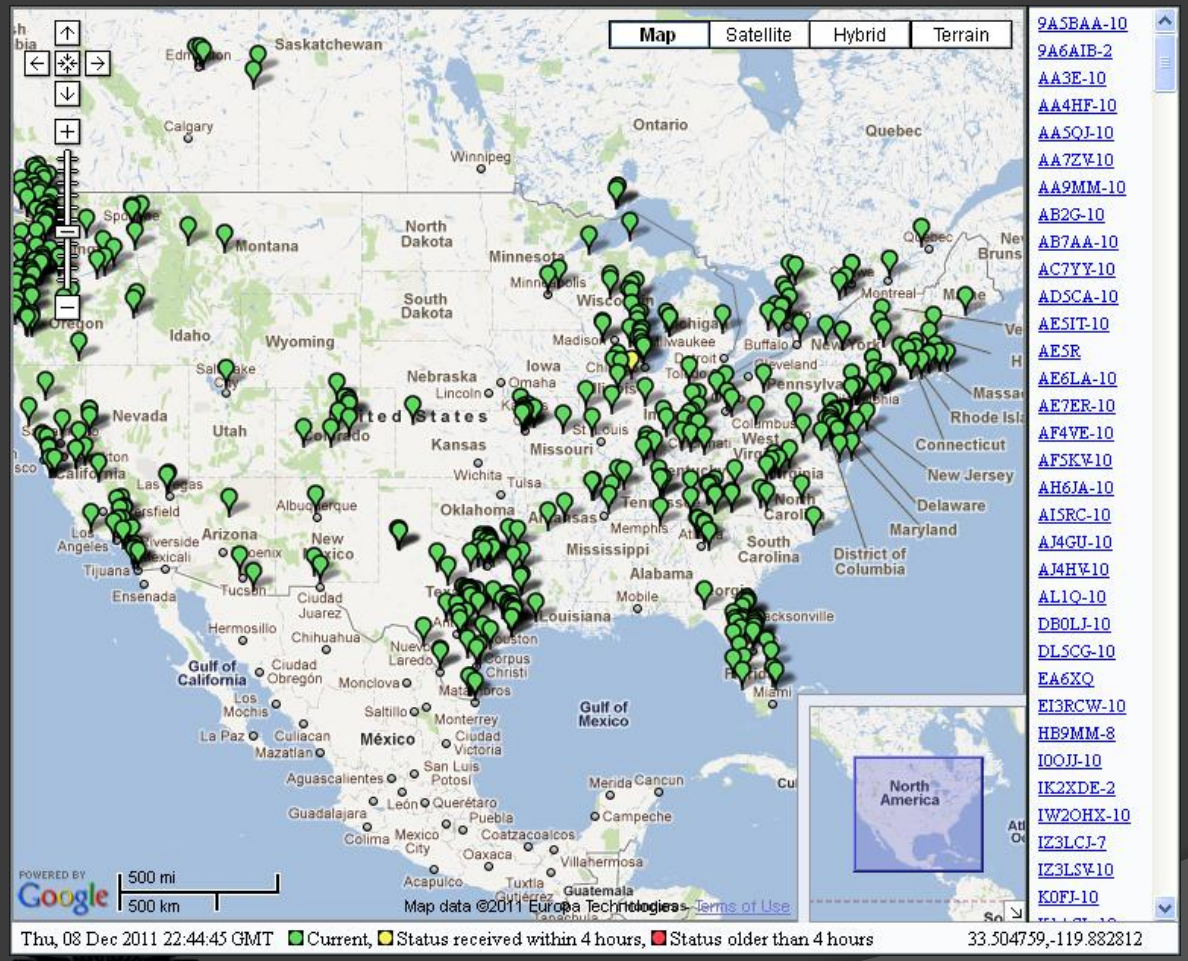
Many “access
points” globally

WL2K Ham HF “Access Point” radio stations



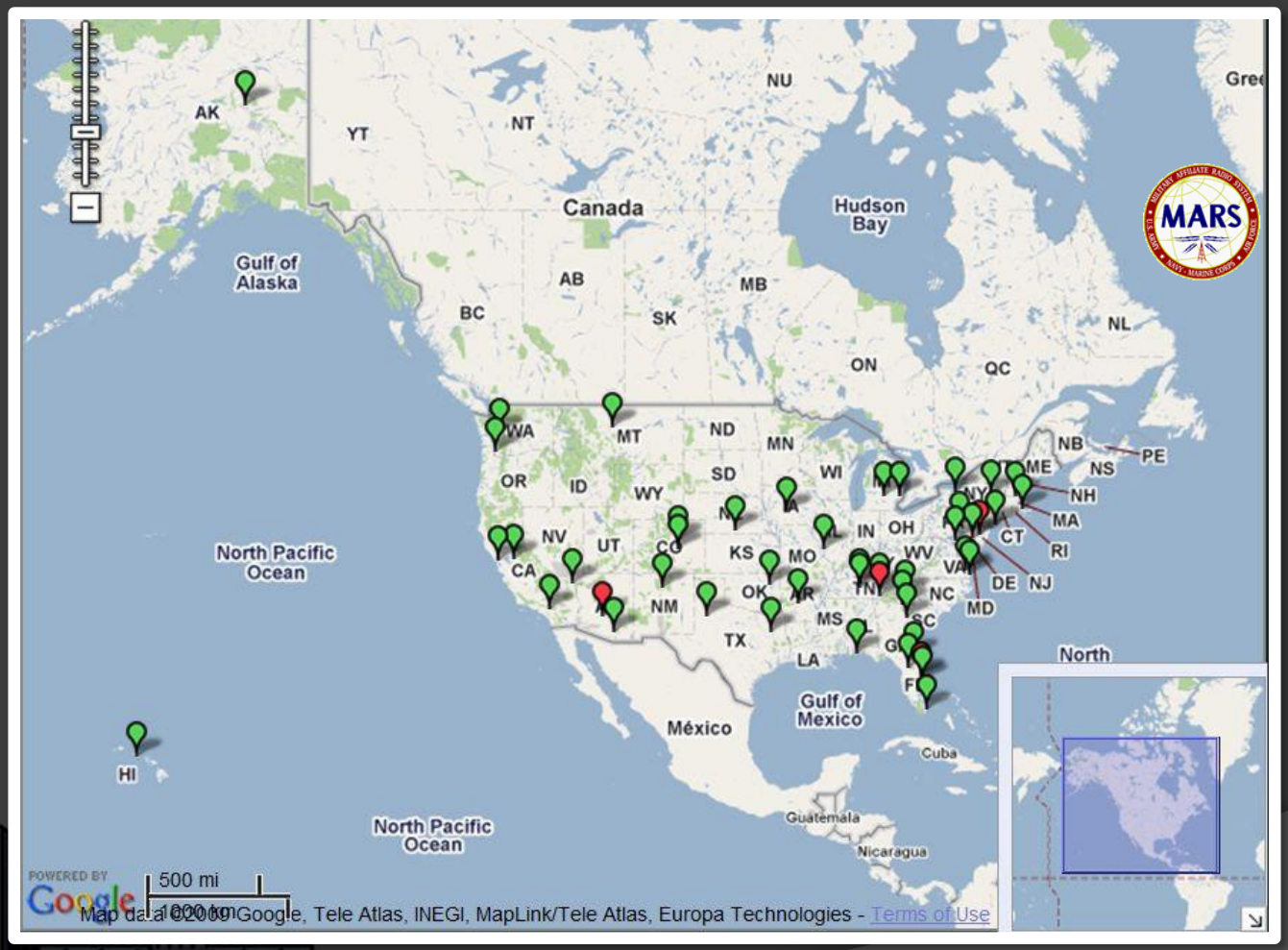
These can be used from hundreds of miles away or more.

WL2K Ham Packet (VHF) stations



These can be used from tens of miles away (but faster than HF).

WL2K MARS HF stations



These can be used by MARS operators only. Less busy than Ham nodes.

WL2K MARS Packet stations

These can be used by MARS operators only. Less busy than Ham nodes.

Our Expanded WL2K Model

- The three hospitals can transparently share a single radio-email station.
- Enables HICS role-based email communications.
- Web-based email interface. No special software needed in user computers other than a web browser.
- Provides full-featured local email capabilities.
- It completely frees the operator from having to handle incoming and outgoing messages locally.

Our Expanded WL2K Model

- Implements bandwidth control strategies for radio email to/from Internet
  - Text-messaging model, separate local and radio-email functions, compression, single destination restriction, traffic-jam bypassing, etc.
- Implements a private local area network for easy access to email from any Wi-Fi-capable device.
- Developed highly-automated communications server with simplified management tools for the radio station operator.
- Can access both, MARS and Ham radio WL2K access point stations.

Our Expanded WL2K Model

In other words:

- Multiple non-technical people can have email service with their own devices.
- No messenger intermediary.
- Simplified management.

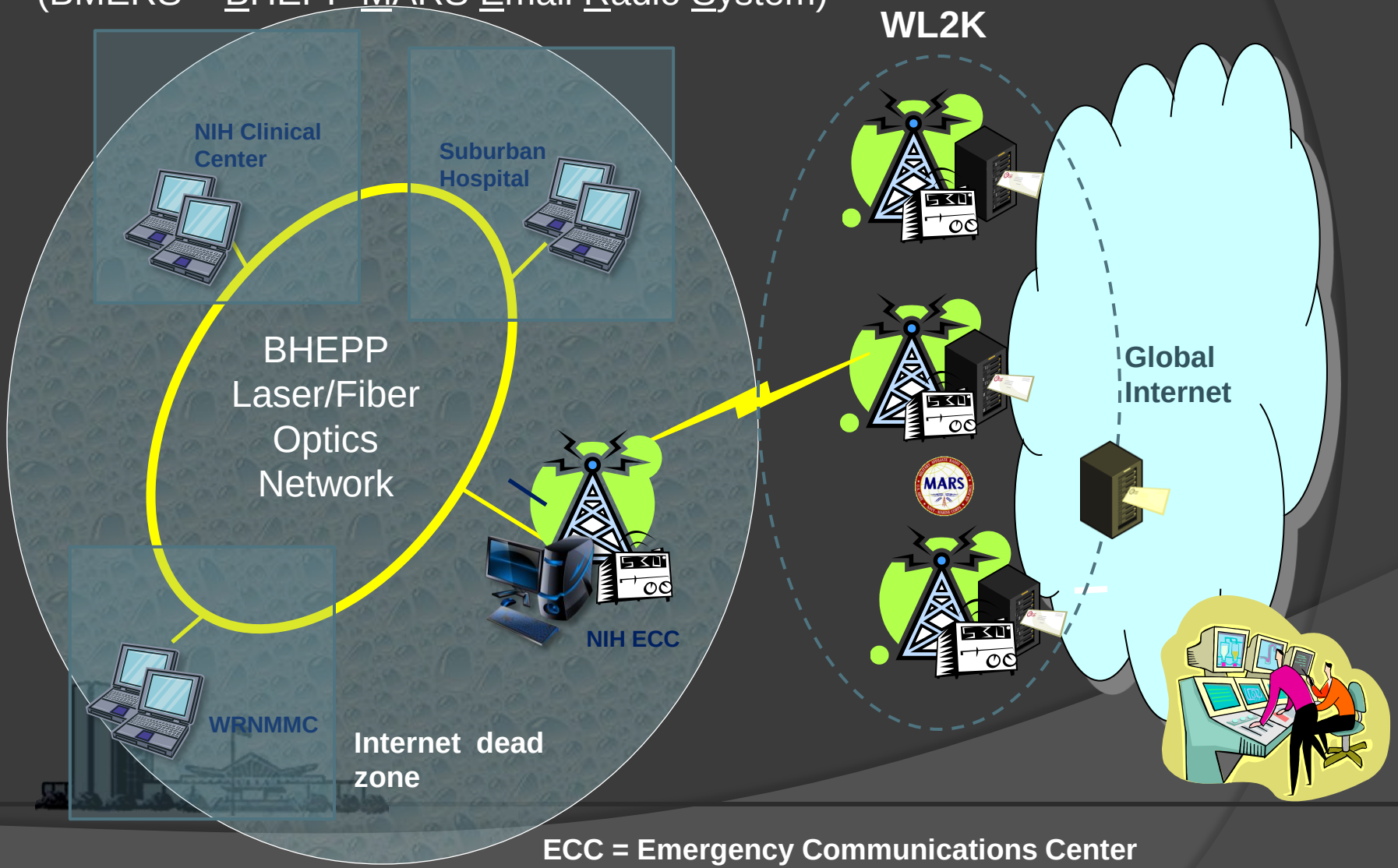
Two implementation lines

- Infrastructural: a “permanent, always-ready” communications service for all hospitals.

  (It makes use of a laser-beam-based private network linking the hospitals –another BHEPP project)
- A portable, highly flexible solution that can be deployed where needed to support a local EOC/HCC or a team in the field.

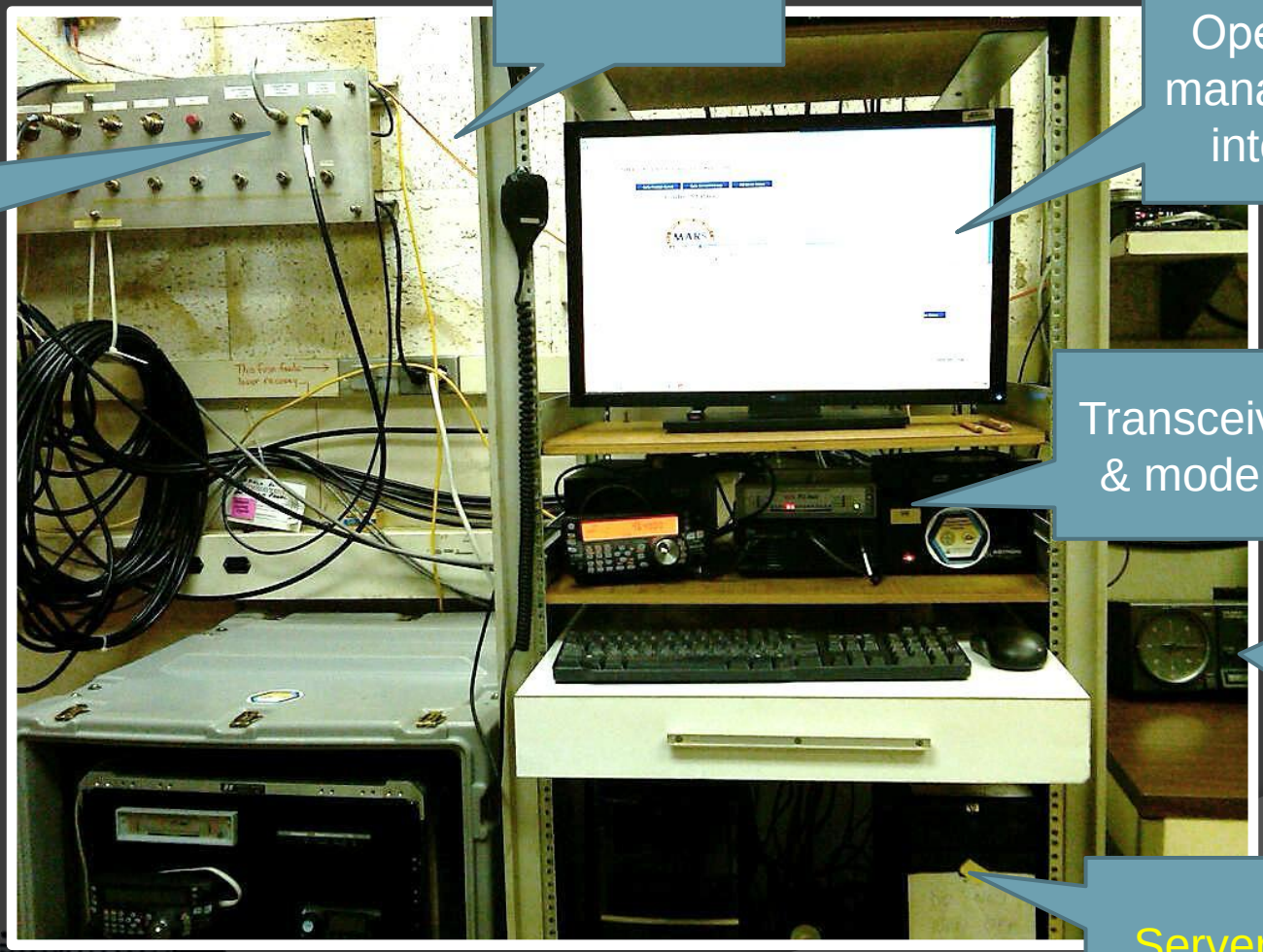
BMERS Architecture

(BMERS = BHEPP MARS Email Radio System)



ECC = Emergency Communications Center

Base Station



Portable/Field Station

Enables a local area network with local and remote email capabilities in the field.

Internet Dead-Zone

LAN 1

Wi-Fi

Wi-Fi

Wi-Fi Bridge

Extended LAN

Portable station

WL2K

Global Internet

MARS

Remote EOC or other

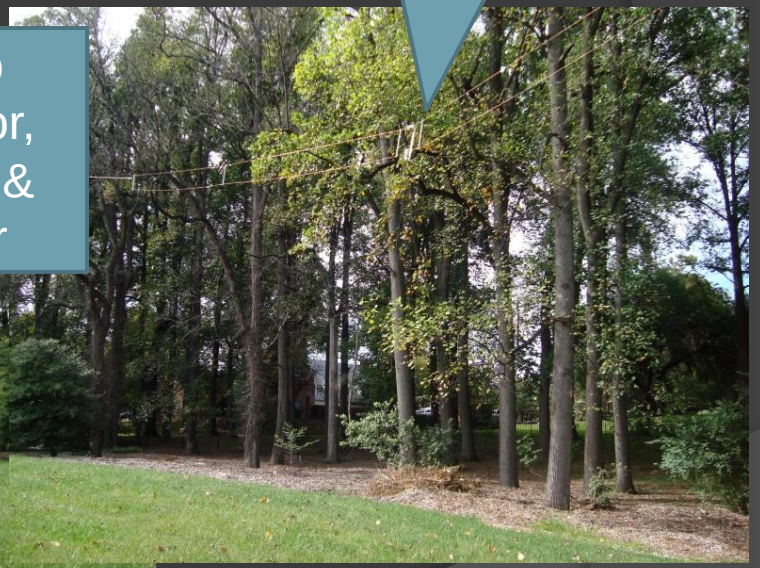
Portable/Field Station

Portable power

HF Antenna for Internet E-Mail

EOC/HCC

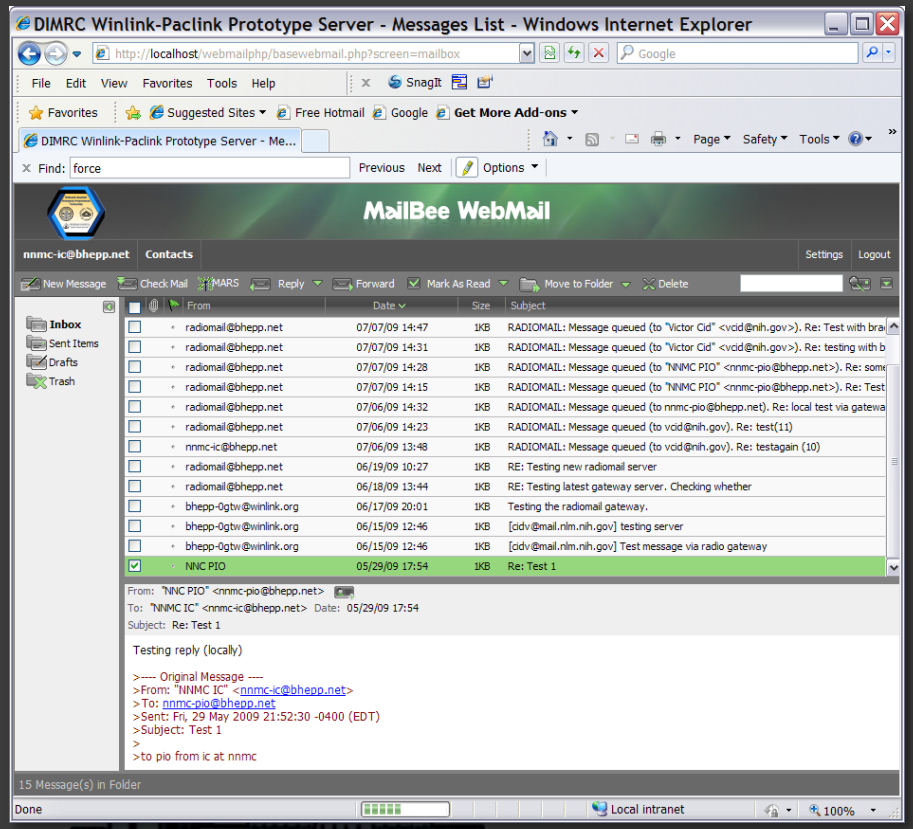
Radio operator, station & server



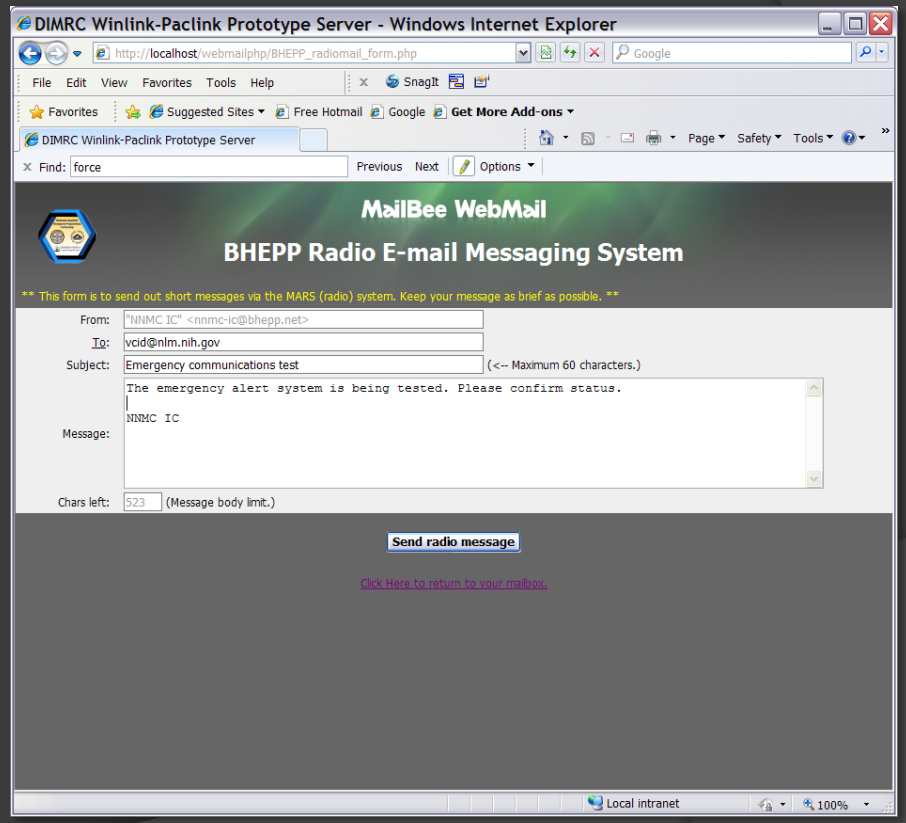
Wi-Fi for local E-Mail access

Radio Email User Interface

Inbox view



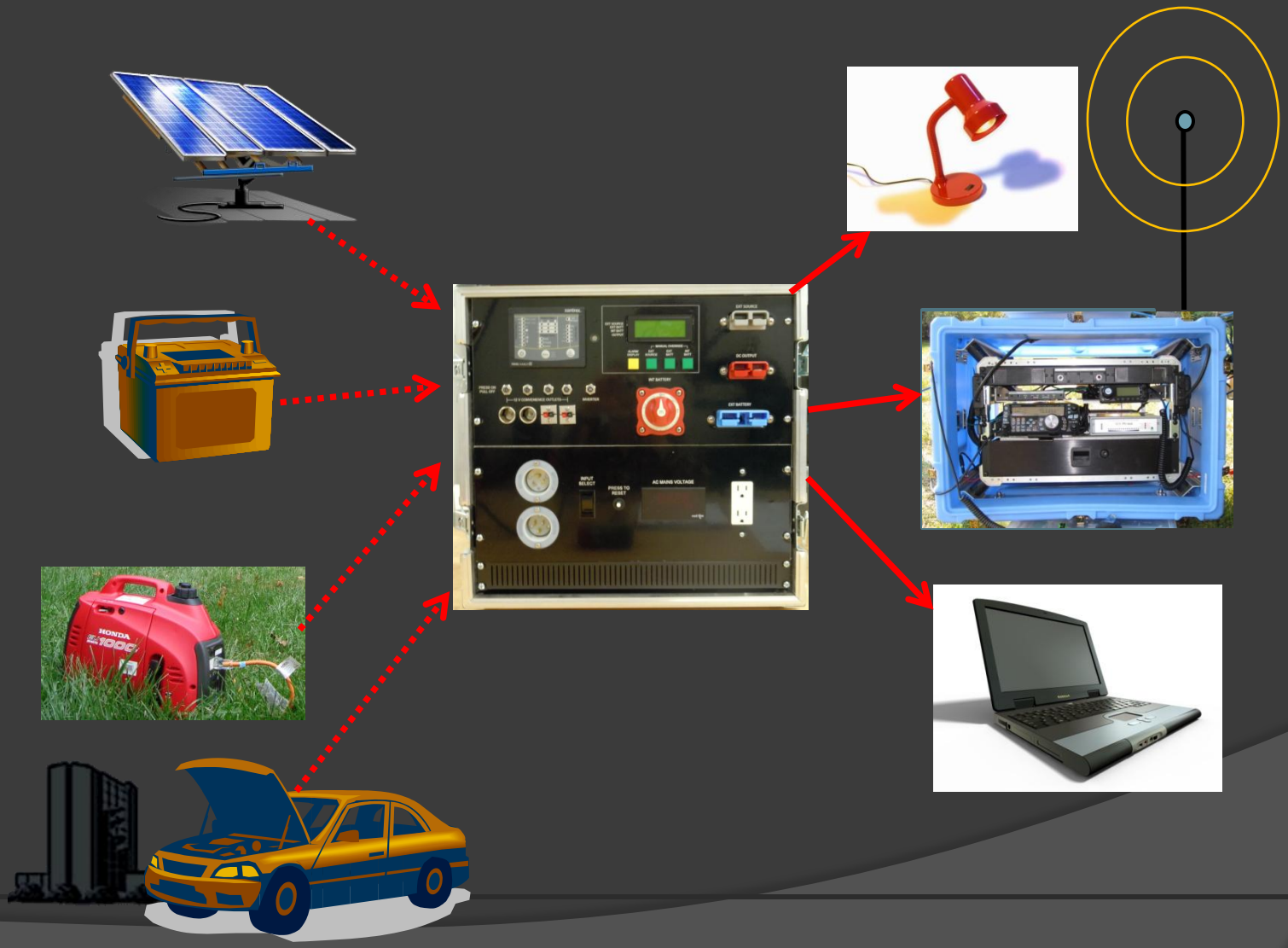
Message composing



BMERS Advanced Power System

- Designed and built custom power system.
- Provides continuous, clean, reliable power for the portable radio station and peripherals.
- Designed as an optional power management system for extended operation of portable radio station.
- Supports multiple power sources and automatically selects best source at any time.
- Power sources can be hot-swapped.

BMERS Advanced Power System



Field Exercises

- Several exercises in NIH campus: simulated support to NIH backup EOC at NIH Fire station
- Exercises/demonstrations at Walter Reed NMMC.
- Used at several CMAX/Capital Shield exercises.

Exercises and Demos

Questions?

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