



# **Warning Communications and Technologies for Alert and Notification Applications**

## **Evaluation Criteria for Architectures and Systems**

**International Tsunami Symposium  
April 20-21, 2015  
Honolulu, Hawaii USA**

**Ed Young  
Kelly Sponberg**

# Architecture Concepts of Redundancy: Eliminating Single Points of Failure

- Circuit Type
  - E.g.- Cellular | FM Broadcast
- Carrier
  - E.g.- Mobile Provider / Carrier | Station
- Channel
  - E.g.- SMS | Frequency / Channel
- Device
  - E.g.- Mobile Handset, GPRS Modem, etc. | Radio Receiver
- Redundancy leads to complexity. Take on only that which can be managed.





# Promoting Diversity in the Architecture to Address

- Transition Threats
- Time of Day Limitations
- Geographic Coverage
- Reach of Device(s)
- Authentication (Cross Reference)
- Active and Passive Alert Purposes
- Opt In or All Within Coverage
- Device Multipurpose or Single Use



# System Specific Considerations

- Costs
  - Differentiate Between Emergency Response and Alert / Notification Systems.
  - Deployment
    - Equipment
    - Setup
    - License
    - Training
  - Operation and Maintenance
    - Recurring Service Fees
    - Per Message / Use Costs
    - Replacement / Maintenance Costs, E.g.- Replace Batteries



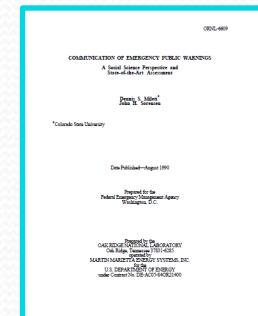
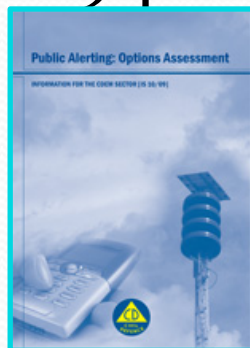


# System Specific Considerations

- Inherent Authentication
- Security and Control
- Message Preservation
- Support of Acknowledgement
  - Source Send
  - Network / Carrier Send
  - Device Receive
  - Human Receive
- Time Performance
- Repeat Frequency / Ability


# Useful References

- NZ Public Alerting: Options Assessment  
<http://www.civildefence.govt.nz/assets/Uploads/publications/is-10-09-public-alerting-options-assessment.pdf>



- Tsunami Warning Center Reference Guide  
<http://www.meted.ucar.edu/communities/hazwarnsys/twcrgr/Tableofcontents.pdf>
- Communication of Emergency Public Warnings  
<http://www.riskred.org/fav/mileti1990.pdf>





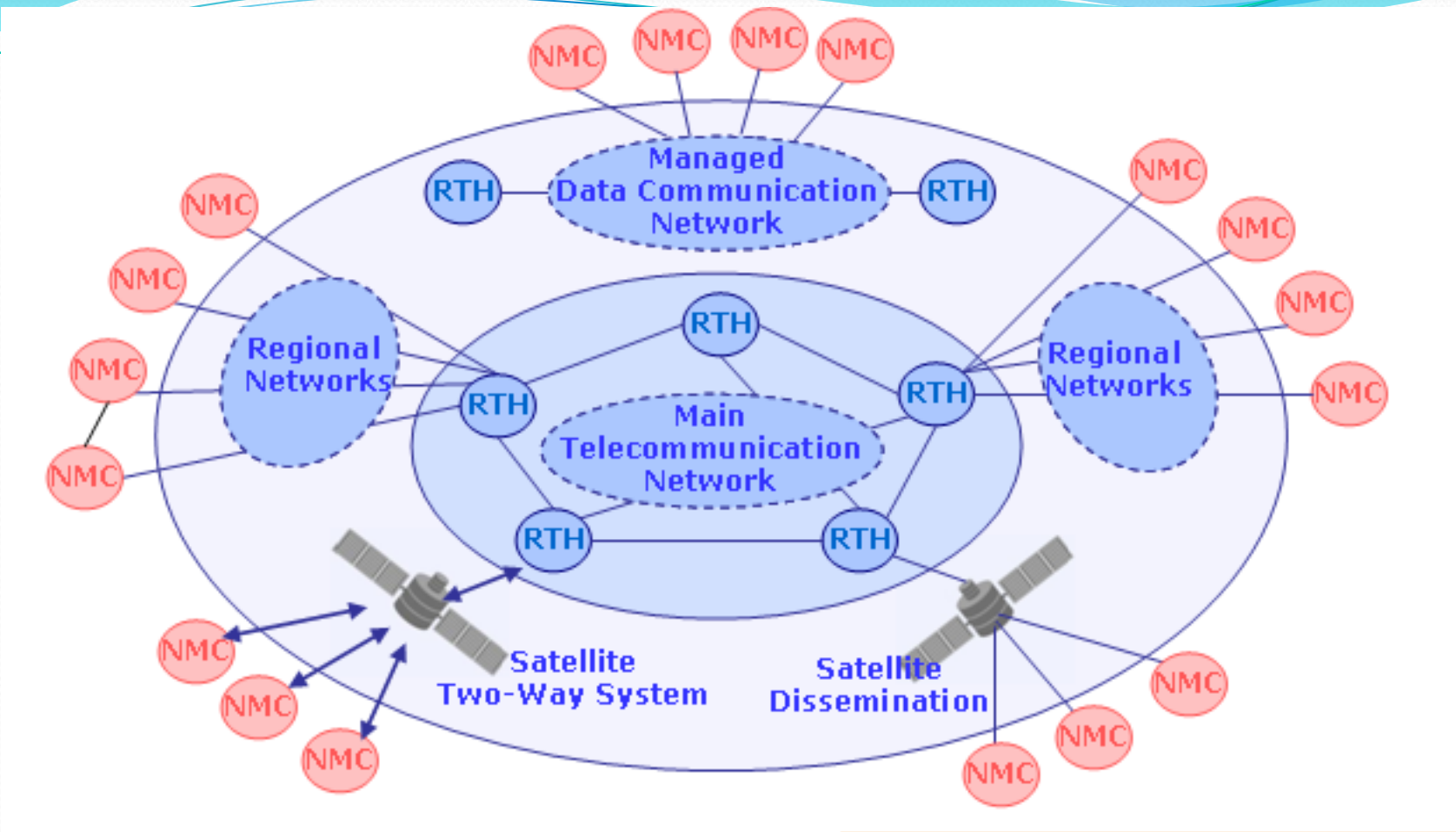
# **Communication Technologies for Alert and Notification Applications**

## **Global Dissemination: WMO WIS / GTS**

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**Ed Young  
Kelly Sponberg**

# WMO GLOBAL TELECOMMUNICATIONS SYSTEM



Regional Specialized Meteorological Centres (RSMCs)

Meteorological and R&D Satellite  
Operator Centres

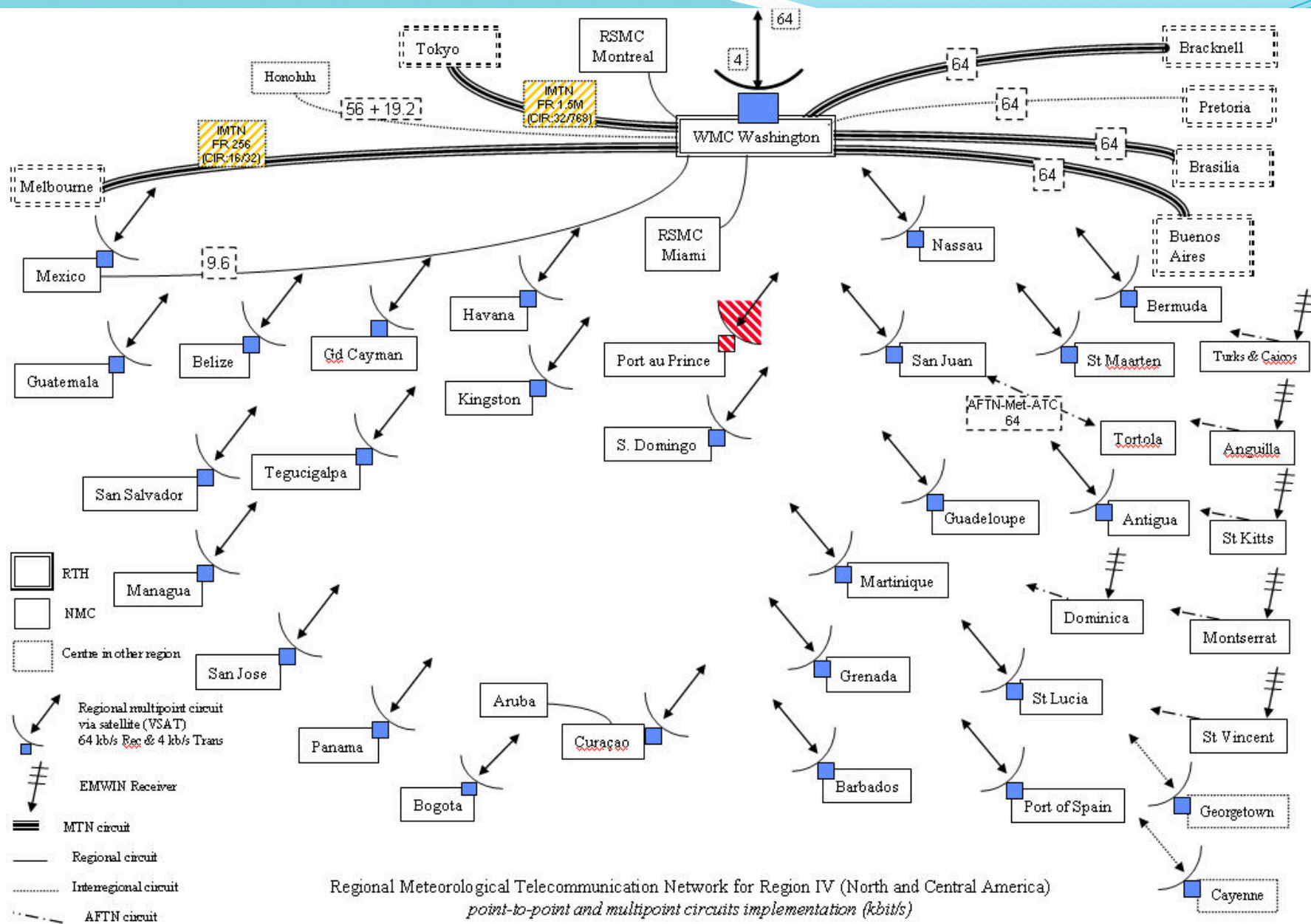
*interconnects*

National Meteorological  
Centres (NMCs)

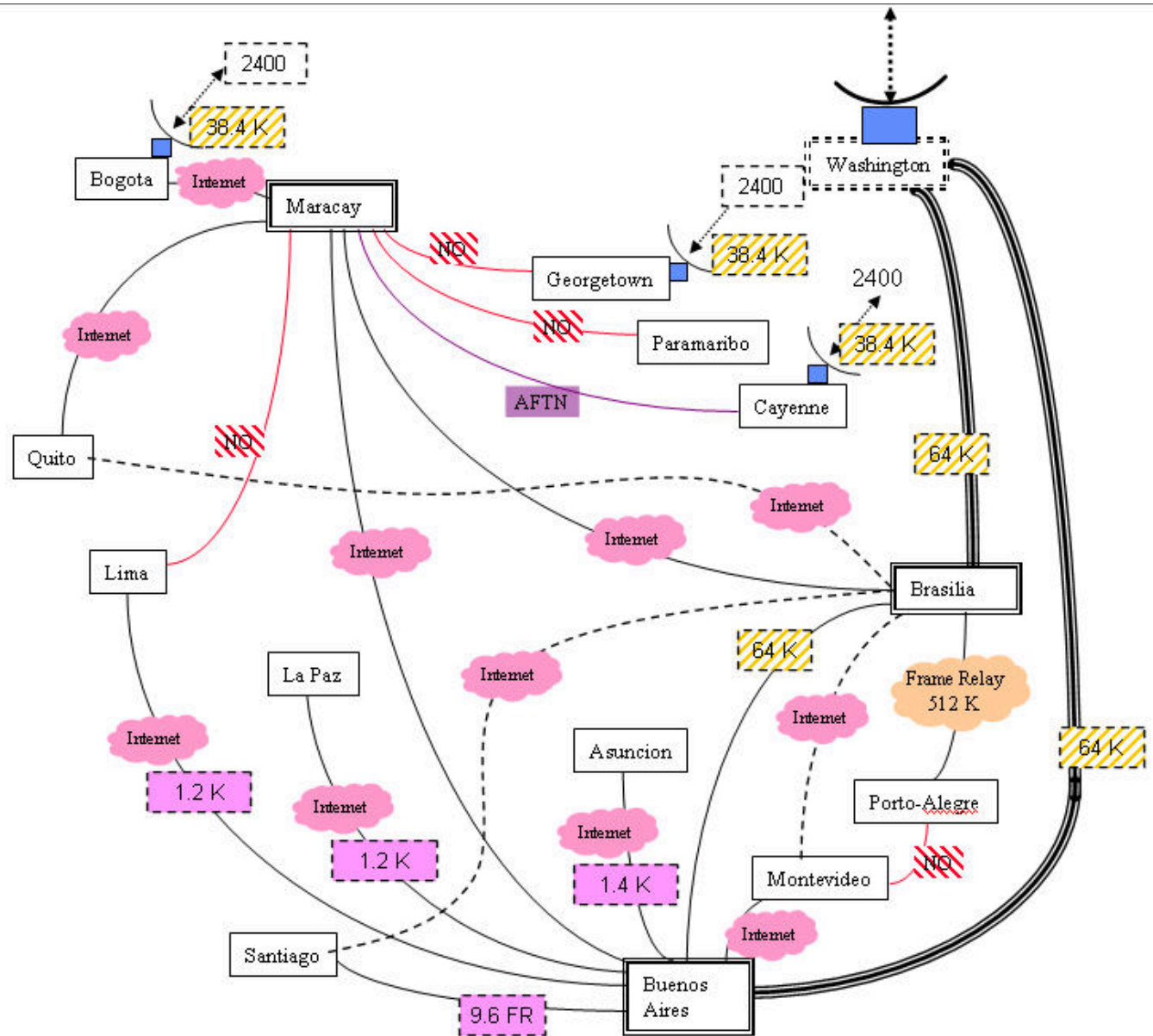
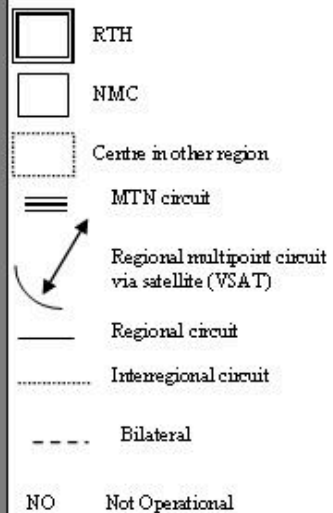
World Meteorological  
Centres (WMCs)



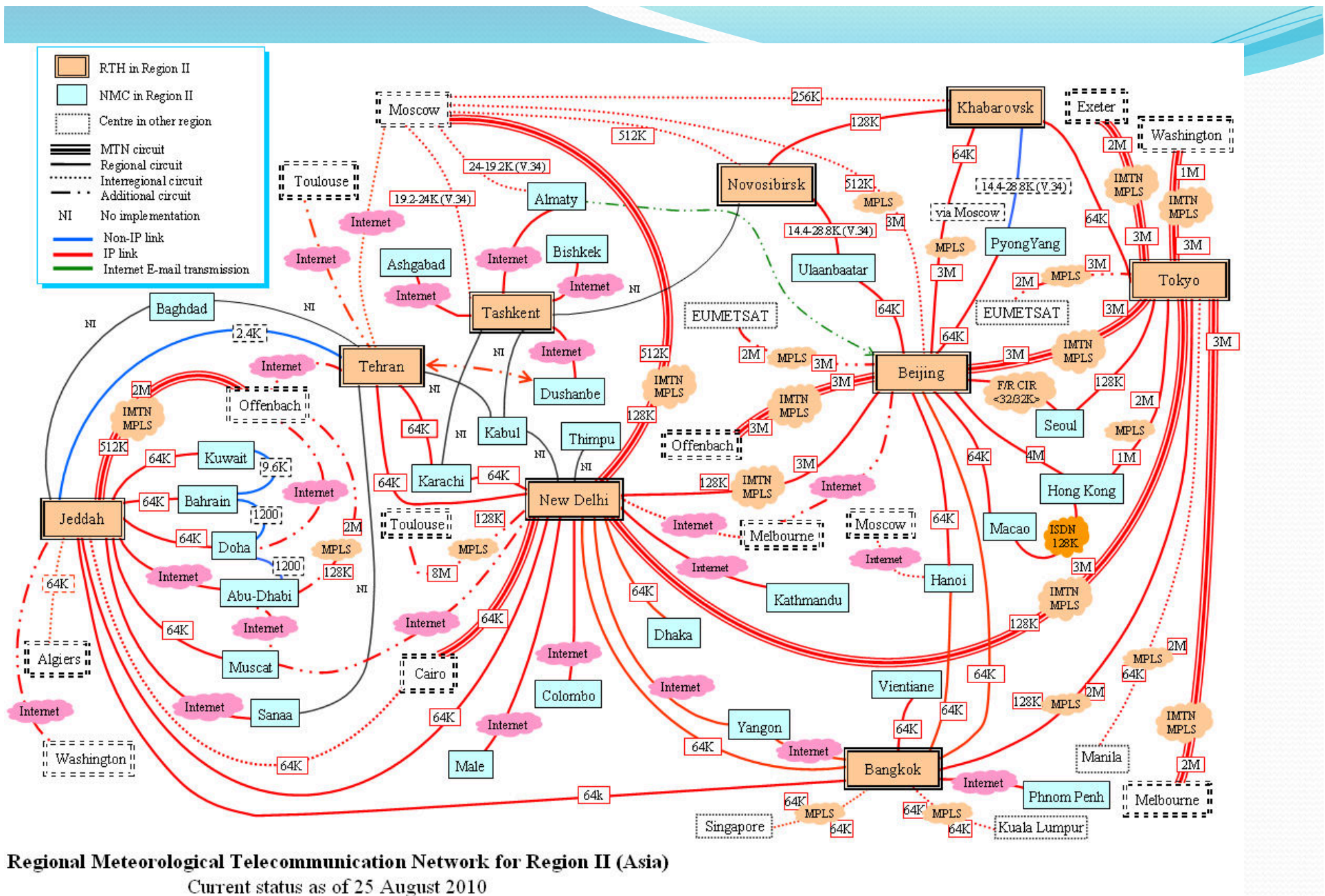








Regional Meteorological Telecommunication Network for Region III (South America)  
*point-to-point and multipoint circuits implementation (transmission speed in bit/s)*







# **Communication Technologies for Alert and Notification Applications**

## **Satellite Dissemination: EMWIN**

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# EMWIN: What is it?

- Emergency Managers Weather Information Network
- EMWIN provides the emergency management community with access to a set of NWS warnings, watches, forecasts, and other products at no recurring cost.







# EMWIN: What is it?

- EMWIN utilizes the US NOAA GOES satellite constellation as its main dissemination mechanism, although with some EMWIN clients, it is possible to receive the EMWIN stream via the internet.
- The broadcast is also mirrored on some private satellites (Ku-band over the US), as well as on other civil / government dissemination platforms, such as LRIT over GOES, PEACESAT, Weather Wire, etc.

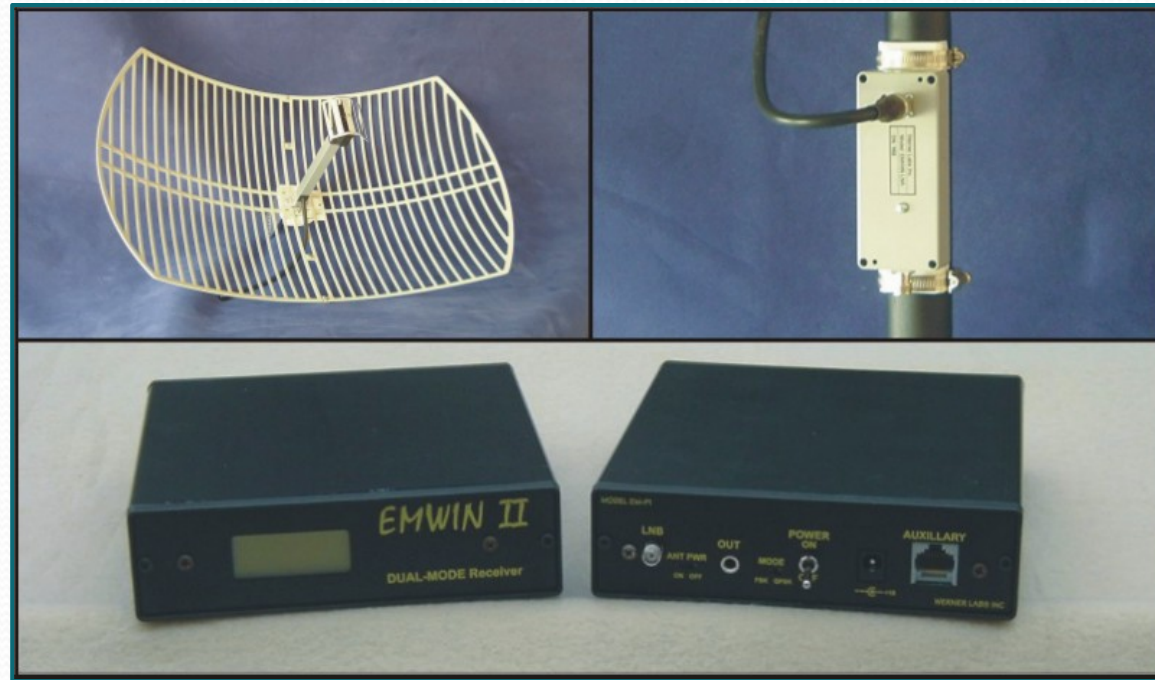


# EMWIN: Generalized Benefits

- Beyond equipment, no recurring fee or subscription cost.
- Very robust system, allowing for information to be received via satellite, thereby avoiding many terrestrial hazards.
- Relatively easy to operate and deploy.
- Depending upon software, capabilities to re-transmit, trigger alarms, send e-mails, archive warnings, etc.

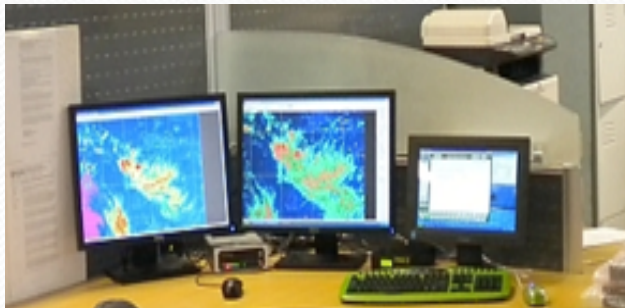


# EMWIN: System Components



*Components of Werner Labs EMWIN-N Receive Station – Antenna, LNA, Receiver / LNB*

# EMWIN: System Components



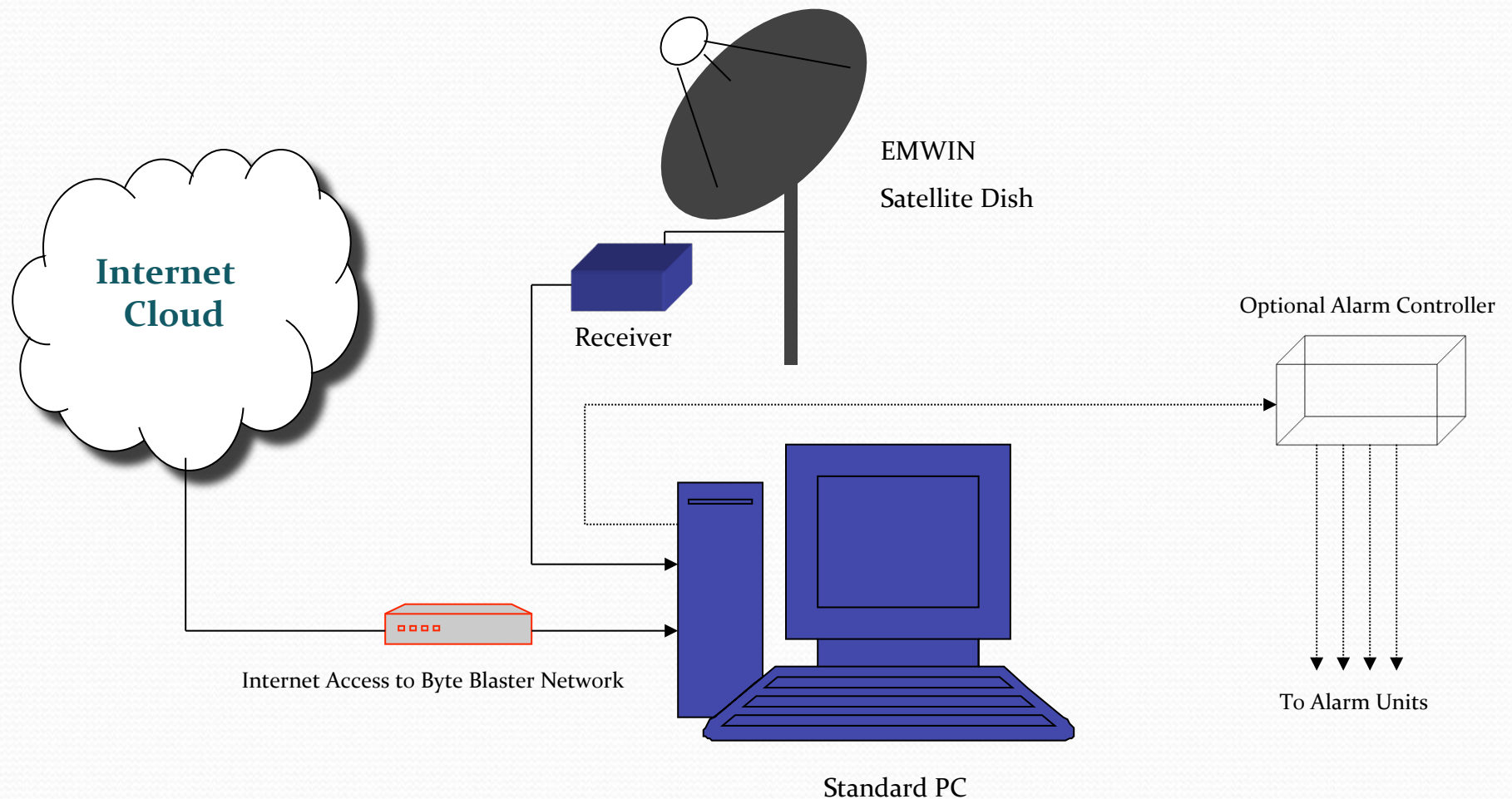
*The EMWIN system at the National Meteorological Service of Vanuatu, and is networked to the National Disaster Management and Geohazards Department.*



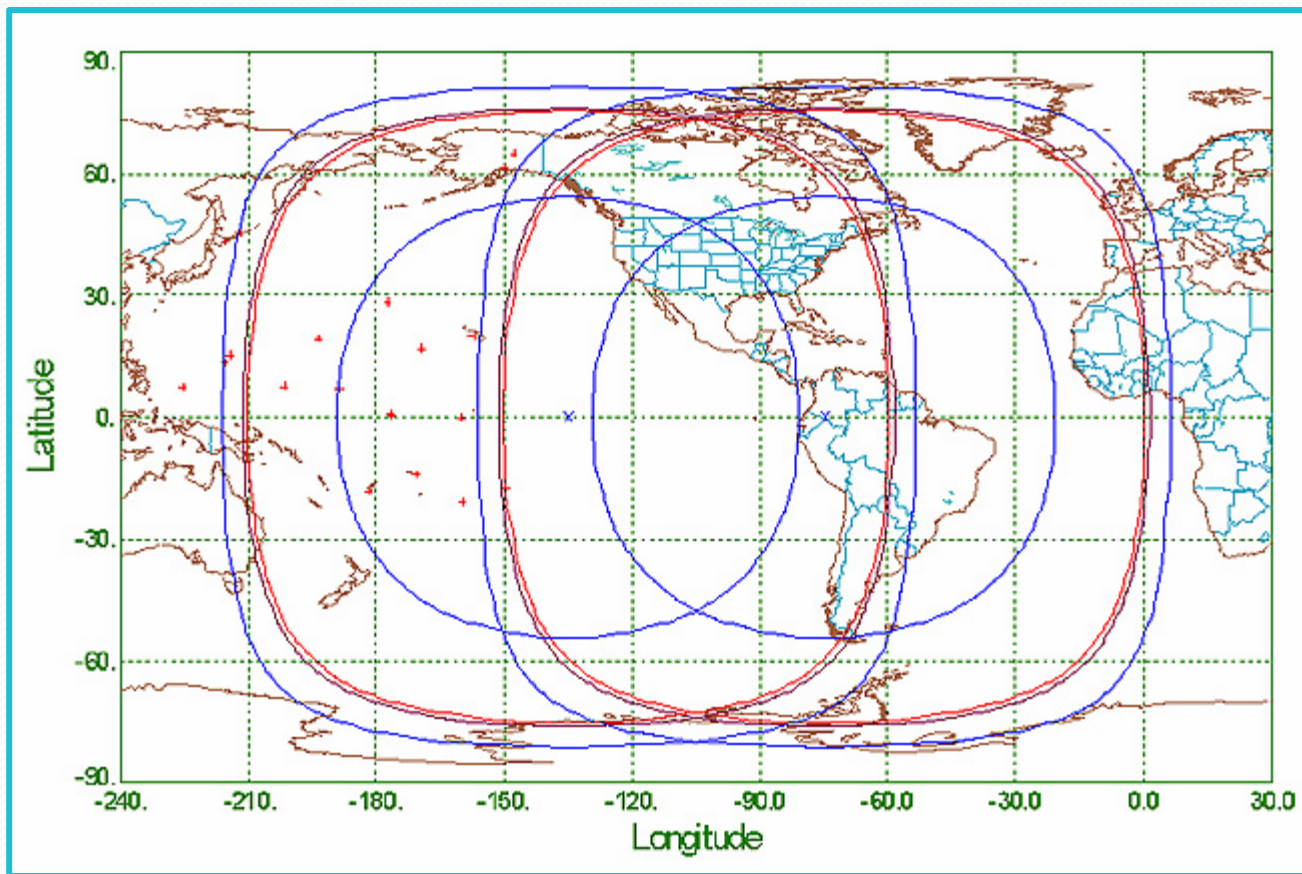
*EMWIN C-Band Dish Antenna at Met Office, Port Vila, Vanuatu*



# EMWIN: System Components



# EMWIN: General GOES Coverage







# **Communication Technologies for Alert and Notification Applications**

## **Satellite Dissemination: LRIT**

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# LRIT: What is it?

- Low-Rate Information Transmission (LRIT) is a standard broadcast method to disseminate satellite imagery and other products via meteorological / environmental satellites.
- LRIT was established by the Coordination Group for Meteorological Satellites (CGMS).
- On NOAA GOES, LRIT carries, in addition to GOES imagery products, EMWIN, tropical cyclone information, DCS, graphics of MeteoSat and MTSAT, and other charts and non-imagery products.
- The broadcast stream is currently 128 kbps. With GOES R it will be expanded to 400kbps and EMWIN and LRIT will merge.



# LRIT: What is it?

- The cost of LRIT stations varies depending upon supplier(s) of hardware and software. Typically, the range is \$8,000 - \$15,000 USD.





# LRIT: Future Transition GOES

- Currently there is a separate EMWIN broadcast, as well as a combined EMWIN and LRIT transmission on GOES satellites.
- Starting with the GOES-R series and generation of satellites, the LRIT and EMWIN services will likely be formally merged into a single channel at 400kbps.
- This provides a potential opportunity for EMWIN users to receive additional information, but a ground station change for both LRIT and EMWIN will likely be needed.
- It is important for potential users of the system to understand that the merge of EMWIN and LRIT on NOAA GOES (effectively removing a separate EMWIN broadcast) is likely ~1-2 years away;



## LRIT: Pacific Transition

- JMA is transitioning to Himawari-8 Cast Service, requiring changes from existing JMA LRIT broadcast
- The technical information on the HimawariCast service has been released on JMA's website.
- [http://www.data.jma.go.jp/mscweb/en/himawari89/himawari\\_cast/himawari\\_cast.html](http://www.data.jma.go.jp/mscweb/en/himawari89/himawari_cast/himawari_cast.html)
- The JCSAT-2A communication satellite will be used when the service begins.
- The JCSAT-2B unit will take over from JCSAT-2A in Q4 of 2015.



# **Communication Technologies for Alert and Notification Applications**

## **Regional Dissemination: GEONETCast & RAPIDCast**

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# GEONETCast: What is it?

- GEONETCast is a near real time, global network of satellite-based data dissemination systems designed to distribute space-based, air-borne and in situ data, metadata and products to diverse communities.
- GEONETCast was established as a Task in the GEO Work Plan and is led by EUMETSAT, the United States, China, and the World Meteorological Organization (WMO). Many GEO Members and Participating Organizations contribute to this Task.

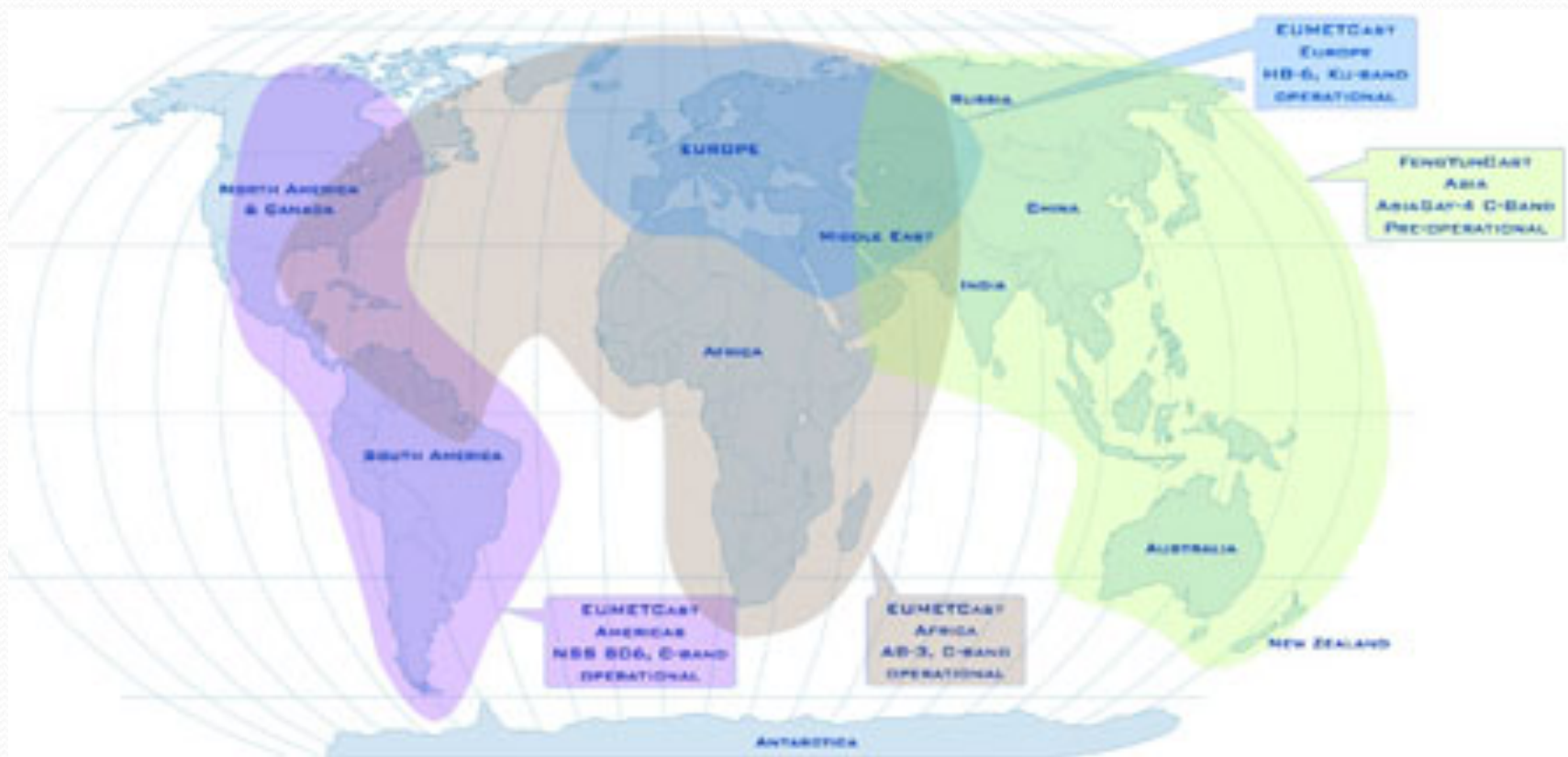


# GEONETCast: What is it?

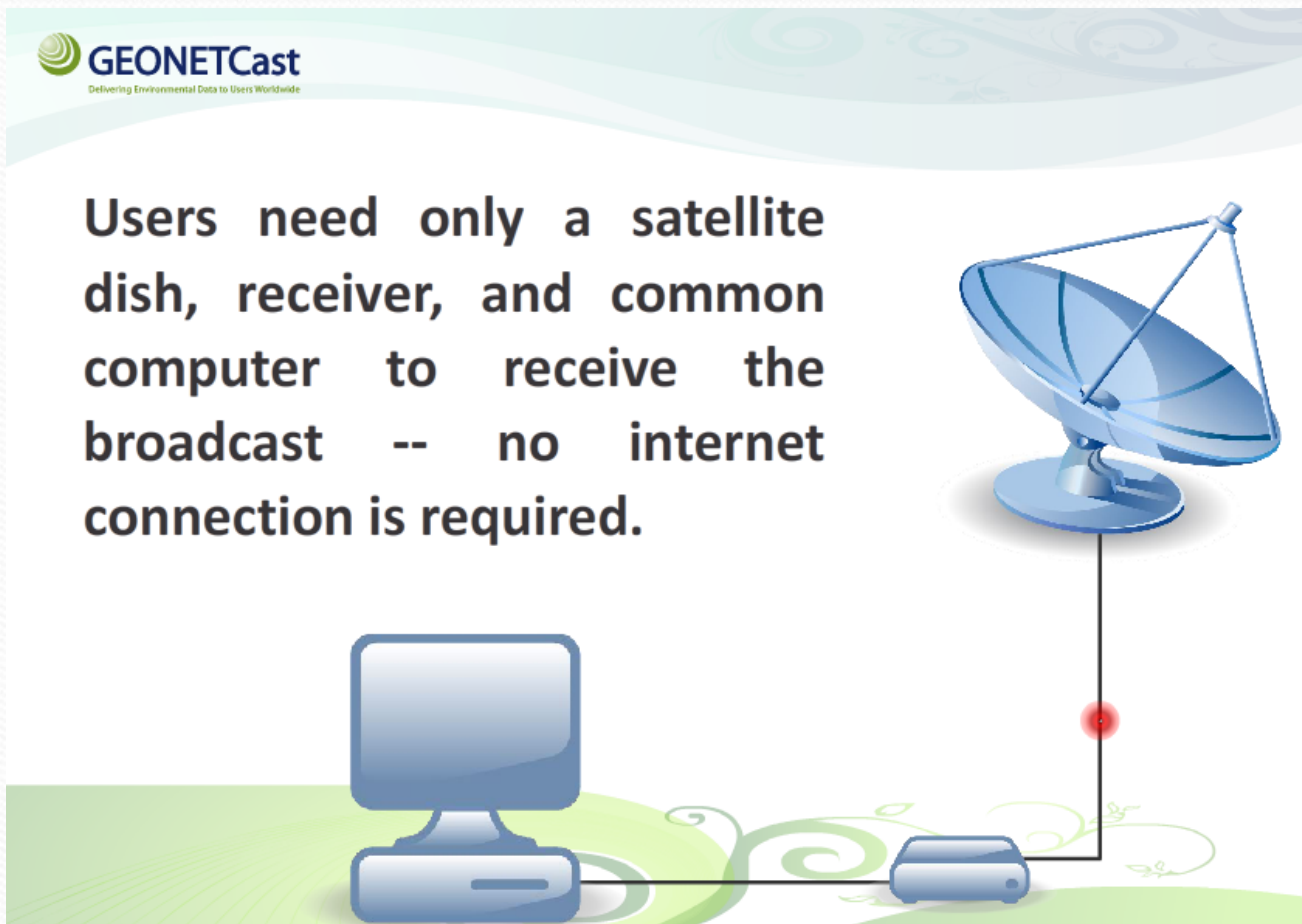
- System utilizes DVB-S/S2 broadcast capacity on mostly commercial satellites.
- GEONETCast Americas operates at 2mpbs, supporting a number of applications beyond the hydro-meteorological or geophysical community.



# GEONETCast Current Coverage



# GEONETCast: Equipment



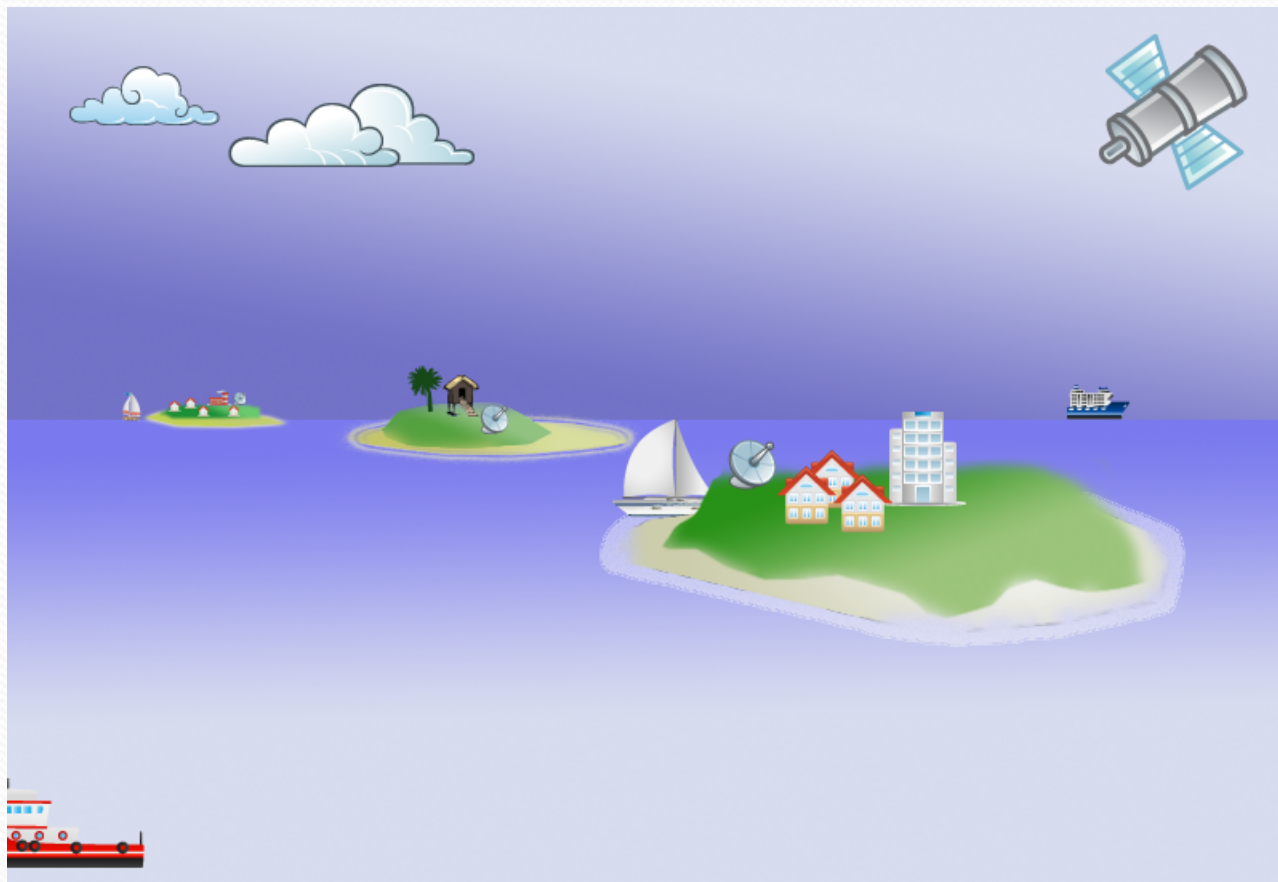




# GEONETCast: Equipment

- GNC-Americas requires a 2.4 meter dish, a DVB-S/S<sub>2</sub> receiver, Kencast client software, and a standard computer.
- Actual station costs may vary depending upon the equipment manufacturer and features purchased. A basic station can be deployed for around \$4,000 USD.

# RAPIDCast

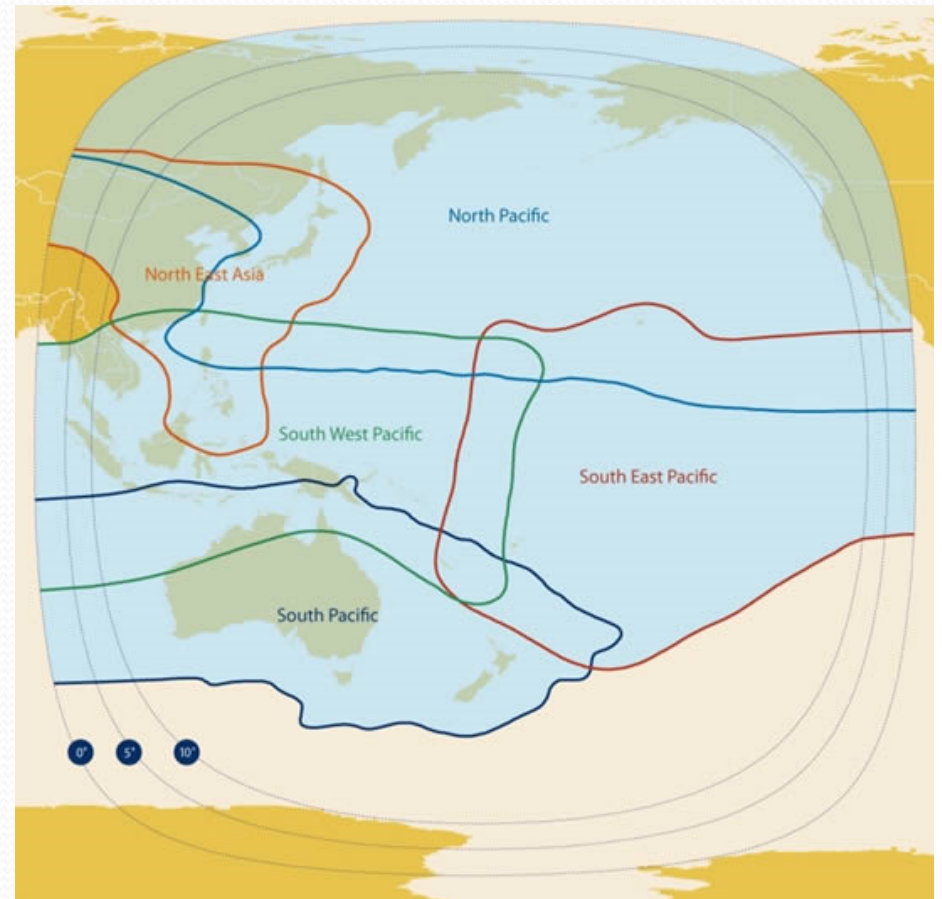




# RAPIDCast

## Remote Asia Pacific Information Dissemination BroadCast

RAPIDCast has the simple goal of providing access to warning, agricultural, and related information to remote areas of the Pacific.

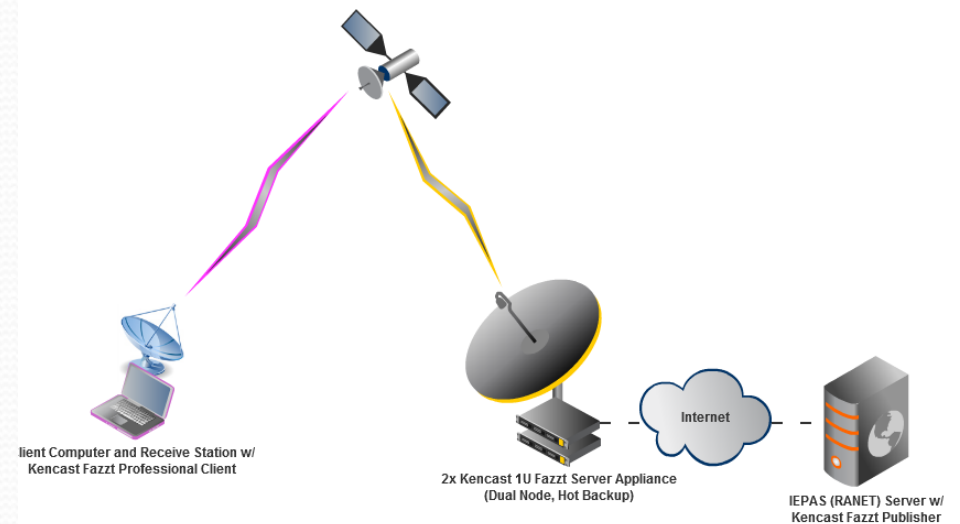


# RAPIDCast

Using a similar dissemination model as experienced with WorldSpace, GEONETCast, and others, RAPIDCast will provide a 128kbps (burst to 512kbps) DVB-S broadcast service on GE-23.

Expect deployment in late 2015.

RAPIDCast: Basic Component Diagram







# **Communication Technologies for Alert and Notification Applications**

## **Cellular SMS in Early Warning**

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# Issues to Address When Using SMS for Alert and Notification

- Weak Authentication
  - SMS sender identifications (numbers, short codes, etc) are easy to spoof. While spoofing in many countries is illegal, this does not make it impossible or terribly difficult.
  - Many users may simply not pay attention or memorize the sender address / ID, allowing spoofing of message formats.



# Issues to Address When Using SMS for Alert and Notification

- Timeliness
  - Cellular networks are vulnerable to congestion, although during congestion SMS is a better communication alternative to voice. E.g.- Australia wild fire SMS notifications took hours.
  - Timeliness is best addressed by limiting your messaging to a closed group (vs public), as well as entering into a dialog with mobile carriers.
  - Depending upon how messages are sent, you will need to set up your messaging system to scale effectively. This is particularly an issue if using GSM modems, or if you have weak internet connections to an SMSC.

# Issues to Address When Using SMS for Alert and Notification

- Network Resilience
  - Cellular networks may be affected (reduced capacity or altogether outage) due to the event for which you are expecting to provide an alert or notification.
  - Cellular networks, however, are often the first communications to be rebuilt post-disaster.
  - There is no real way to deal with outages or congestion, except by ensuring your overall network architecture utilizes several other means of communication.



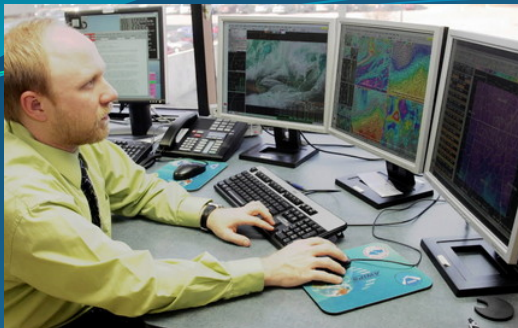


# **Communication Technologies for Alert and Notification Applications**

## **Cell Broadcast**

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**WIRELESS  
EMERGENCY  
ALERTS  
CAPABLE**



Wireless Emergency Alerts (WEA)

**Cell Broadcasts in the U.S.**



# Commercial Carriers and Government Respond to the Need for Mobile Alerts



WARN Act of 2006 authorized DHS and FCC to begin activities toward development of a Commercial Mobile Alert Service (CMAS)



**In 2007-08, joint Commercial and Government (all levels) committee developed recommendations for mobile alerts**

- **Cell tower broadcast (not SMS text), so no network congestion**
- **County level alerting, but sub-county encouraged/expected**
- **90 character maximum**
- **Opt-out**

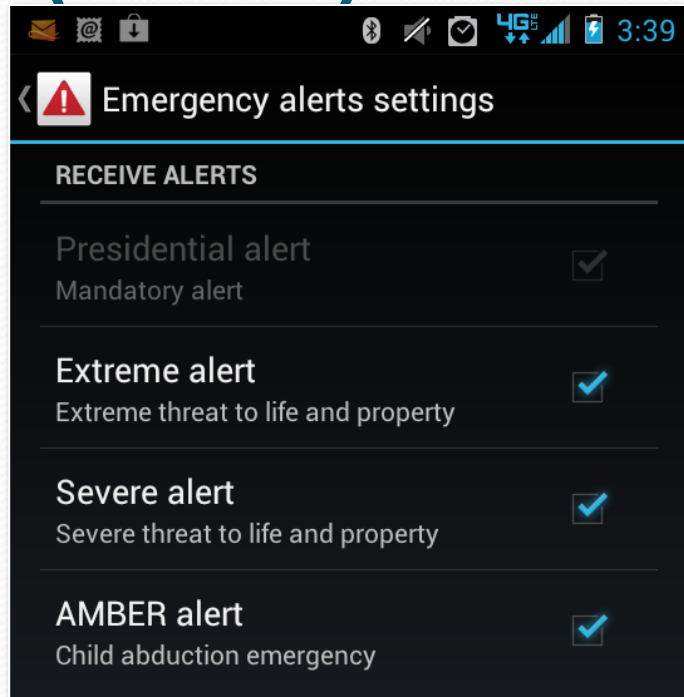


August 20, 2014

## **Rollout**

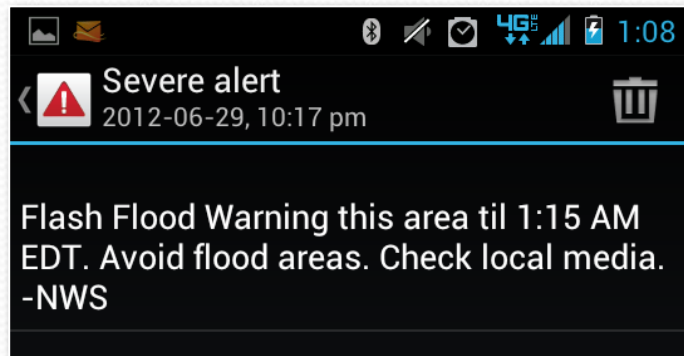
- **Called Wireless Emergency Alerts (WEA) by carriers**
- **Carrier rollout started April 7, 2012)**
- **NWS push to WEA via FEMA IPAWS began June 28, 2012**

# Wireless Emergency Alerts (WEA)



## Alert Categories

- Presidential
- Imminent threat to life and property (e.g., severe weather, HazMat, earthquake)
- AMBER Alert/child abduction



## Alert Message Content (90 characters)

- What is happening
- Area affected
- Til time
- Recommended action
- Alert originator

August 20, 2014



# Quick Facts about WEA

- Purpose to notify (i.e., a bell ringer), recipient should seek details from traditional sources
- Is a free opt-out service
- Uses cell broadcast technology
  - **Merely a radio broadcast, so the service doesn't track you**
  - **Alerts not subject to network congestion as with traditional text messaging**
- Major carriers are committed to producing WEA capable phones
- If you travel into an alert area after the alert was originally sent, you should still receive it
- Each WEA is only displayed once, so you don't receive duplicates
- WEA has a distinct vibration cadence and audio tone
- Alerts do not interrupt when you are in a voice or data session on the device

# WEA Availability

- WEA-capable cell phones
  - Dramatic increase in WEA-capable cell phones on market (too many to list)
  - Usually called Emergency Alerts (Android) or Government Alerts (iPhone)
- Coverage
  - “Big Four” fully rolled out across their networks
- Contact your carrier for questions
  - See [CTIA.org/WEA](http://CTIA.org/WEA)



# WEA Messages Originated by NWS

## Extreme

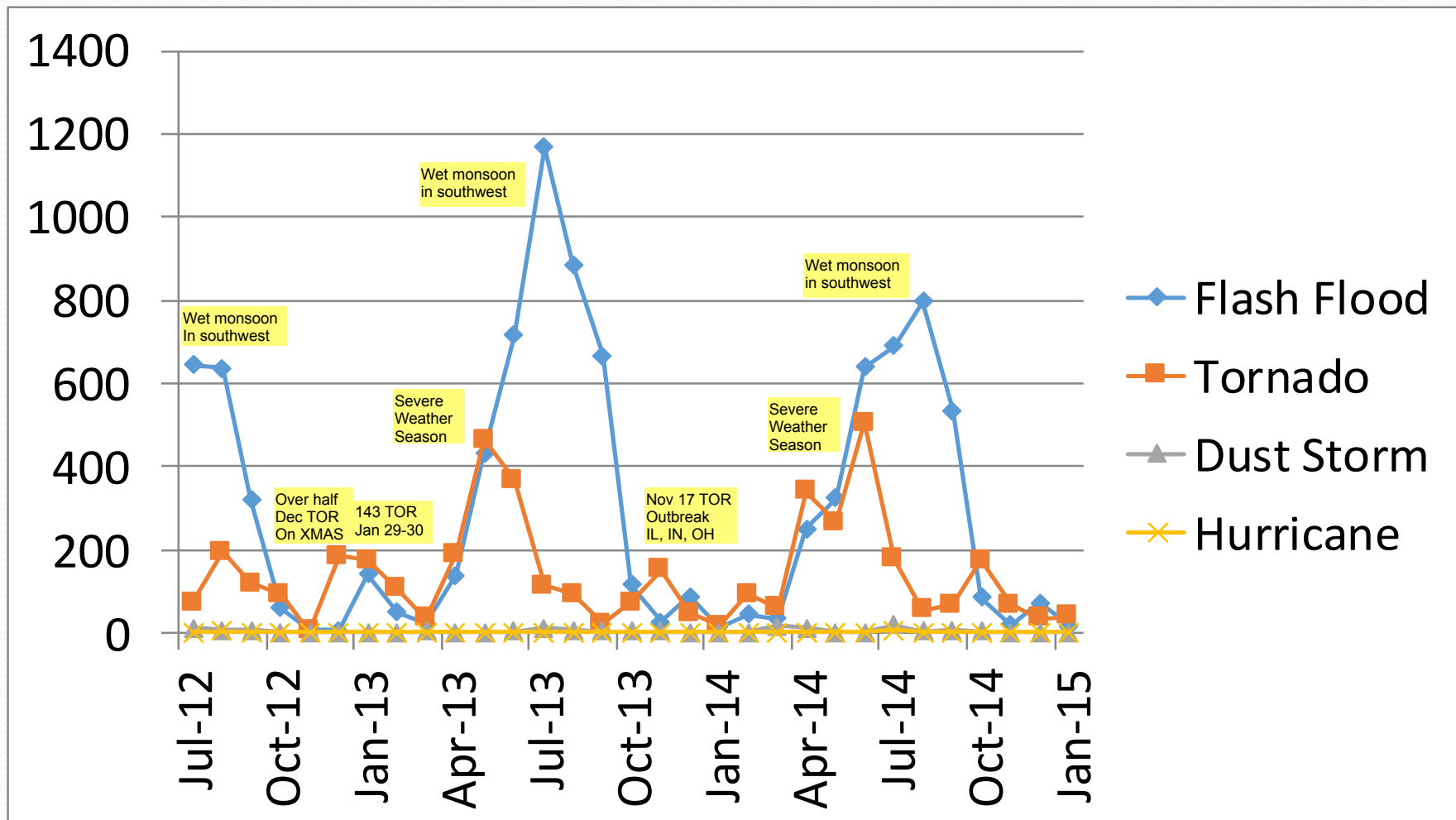
Warning Type	WEA Message
Tsunami Warning	Tsunami danger on the coast. Go to high ground or move inland. Listen to local news. -NWS
Tornado Warning	Tornado Warning in this area til hh:mm tzT. Take shelter now. Check local media. -NWS
Extreme Wind Warning	Extreme Wind Warning this area til hh:mm tzT ddd. Take shelter. -NWS
Hurricane Warning	Hurricane Warning this area til hh:mm tzT ddd. Check local media and authorities. -NWS
Typhoon Warning	Typhoon Warning this area til hh:mm tzT ddd. Check local media and authorities. -NWS
Flash Flood Warning	Flash Flood Warning this area til hh:mm tzT. Avoid flooded areas. Check local media. -NWS
Dust Storm Warning	Dust Storm Warning in this area til hh:mm tzT ddd. Avoid travel. Check local media. -NWS

## Severe

Legend  
 Extreme  
 Severe  
 Moderate  
 Minor  
 Watch  
 Advisory

# NWS Warnings Activating WEA

(Approximate)





# Becoming an Alert Originator



**Plan, Prepare & Mitigate**  
Before, During & After a Disaster

**Disaster Survivor Assistance**  
Hurricane Sandy, Apply for Assistance,

**Response & Recovery**  
Tools, Teams, Individual & Public Assistance

**Topics & Audiences**  
Grants, How to Help, Private Sector, Think Tank, Tribal

**Blog, Newsroom, Videos & Photos**  
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→ Protecting Homes

→ Protecting Our Communities

→ Protecting Your Businesses

→ National Preparedness

→ Preparedness (Non-Disaster) Grants

→ Assistance To Firefighters Grant Program

→ Hazard Mitigation Assistance

→ Continuity of Operations

↓ **Integrated Public Alert and Warning System**

- ▶ **Alerting Authorities**
- ▶ Private Sector Industry
- ▶ Non-Profit and Advocacy
- ▶ American People

**Integrated Public Alert & Warning System** [Share/Email This Page]

**Related Links**

- [IPAWS Alerting Authority Online Training \(IS-247.a\)](#)
- [Receive emails about IPAWS news and webinars](#)
- [Wireless Industry Information on WEA](#)
- ["Cheat Sheet" Video on WEA](#)

**State and local alerting authorities are signing up to use IPAWS. View a list of [IPAWS Alerting Authorities](#) in each state.**

**Learn more about [Wireless Emergency Alerts](#) (WEA).**

- **Around 300 Emergency Managers are capable**

State/Territory	Alerting Authority
AK	Kenai Peninsula Borough Office of Emergency Management
AK	State of Alaska Division of Homeland Security and Emergency Management
AL	Baldwin County
AL	Jefferson County
AL	Mobile County Emergency Management Agency
AL	University of Alabama
AR	Arkansas Department of Emergency Management
AR	Benton County Office of Emergency Communications
AR	City of North Little Rock
AZ	Arizona Division of Emergency Management (ADEM)
AZ	Maricopa County Department of Emergency Management
CA	California Governor's Office of Emergency Services
CA	City of Monterey Park
CA	City of Moreno Valley Emergency Operations Center
CA	City of San Leandro
CA	Contra Costa County Office of the Sheriff
CA	County of Los Angeles
CA	County of Sacramento
CA	County of Tulare
CA	Monterey County
CA	Northern California Regional Intelligence Center
CA	Orange County
CA	Riverside & San Bernardino Counties (LECC)
CA	San Diego County Office of Emergency Services
CA	San Francisco Department of Emergency Management
CA	San Joaquin County Office of Emergency Services
CA	San Luis Obispo County Office of Emergency Services
CA	Siskiyou County
CA	Ventura County Sheriff's Office - Office of Emergency Services

<http://www.fema.gov/integrated-public-alert-warning-system-authorities>

<http://www.fema.gov/ipaws>

# Improvements to WEA

- WEA activation for extreme T-storms being actively explored. *Stay tuned!!*
- NWS next gen warning tools under development
  - Activate WEA based on impact rather than product type alone
  - Exploring tsunami WEA activation by polygon
- **Improvements to WEA Testing and Deployment**
  - WEA testing recommendations reported to FCC during Summer 2014
    - Local testing with trusted opt-in audience such as spotters, civic groups, etc.
    - Status: under review by the FCC
  - Geo-targeting/message length/content recommendations sent to the FCC in Dec 2014
    - **Increase maximum message length from 90 to 280 characters on 4G LTE**
    - Feasibility study for including graphical info (e.g., threat area map with user location or photo)
    - Feasibility study for mobile-assisted geo-targeting
    - Develop WEA Geo-targeting Best Practices for cell broadcast
    - FEMA enhance Alert Originator training on WEA message composition
    - Others





## Communication Technologies for Alert and Notification Applications

### Mobile Phone Applications

- The City and County of Honolulu, in conjunction with the State of Hawaii Emergency Management Agency and the University of Hawaii Coastal Storms Program, has developed a "**Ready Hawaii**" App that users can download free from the **Apple** and **Android** stores.
- This app will help residents and visitors in Hawaii be better prepared through the use of this interactive app.
  - Features include a disaster planning tool, disaster preparedness kit checklist, interactive maps to determine shelter and evacuation zone locations, information on various threats in Hawaii, contact information statewide, links to major news sources, and inclusion of major alerts.
- Also included is an alert module that will alert users to major watches and warnings, as well as a history of disasters in Hawaii.



# **Communication Technologies for Alert and Notification Applications**

## **Terrestrial Radio and RDS / Tone Alert**

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**Ed Young  
Kelly Sponberg**





# Multiple Application Scenarios

- Relaying information on existing FM/AM stations (commercial or community / non-profit owned).
  - Primarily requires development of partnership, with some consideration of how to timely and reliably pass information. Time intensive, but least expense.
- Community Radio Station Setup
  - Time intensive and costly. Significant listener benefits and trust building.
- Dedicated Gov / Warning Authority Station
  - Less time intensive and some significant cost.
  - Very useful for establishing cross-reference authentication, providing detailed message information, and supports many passive roles.



# Cost of Stations

- Varies widely depending upon broadcast power, sophistication and automation of equipment, etc.
- A minimal low-power / community FM radio station can be purchased for \$6-8K, however, deployment expenses, spare parts, etc., likely means a budget of \$25K a station.
- Licensing with national regulatory agency may require additional one time or recurring fees.
- Power, if using solar, wind, or generator, adds another significant upfront and recurring cost.





# Indirect Cost Considerations

- Training, training, training, training.
  - Operators and listeners.
- Record keeping and regulatory compliance.
- Maintenance



# RDS & Tone Alert: What is it?

- Radio Data System (RDS) is a digital carrier on an existing radio broadcast that can be used to send short (very short) text information or used as a trigger for receivers in stand-by.
- Tone Alert is a encoded signal in a radio broadcast that can be used to trigger radio receivers in stand-by.
- Such trigger systems are useful for remote alarm and receiver activation. E.g.- NOAA Weather Radio.





# **Communication Technologies for Alert and Notification Applications**

## **High Frequency (HF) Radio**

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Kelly Sponberg**



# HF Radio: What is it?

- High Frequency (HF) radio is an ‘old’ technology often used in emergency situations for its robustness and ability to transmit over large distances.
- HF is typically used for two-way audio / voice services, but data applications are available and common.
- Bandwidth over HF is extremely limited, so if used for data services, the application should be limited to short text messages.





# HF Radio: What is it?

- HF likely already exists in many government entities (police, military, etc), and weather services typically have been licensed some frequencies to use for data recording and exchange.
- Large amateur radio networks exist, which can make HF a valuable tool pre- and post-disaster for getting messages to and from communities.
- Note, however, that day-to-day operations cannot and should not run under ‘HAM’ / amateur licenses.



## HF Radio: Limitations / Considerations

- Operation of HF 'rigs' often requires site and operator licensing, which depending upon local regulations can result in fees and/or limit use to a select few.
- Outside of regulation, HF tends to require technically trained personnel for operation.
- Equipment (for long distance communications) is relatively expensive. A digital / packet enabled station will cost \$12-20K.
- Point-to-point / minimal broadcast capability as defined by likely limited set of deployed station. Best as a government coordination tool.





## HF Radio: Limitations / Considerations

- Atmospheric / solar conditions greatly affect HF signal quality, therefore either personnel must be trained to switch frequencies, or automated devices will need to be added to an HF unit to address such issues.
- Despite cost and limitations, a very, very useful tool to ensure basic communications pre- and post-disaster.







# **Communication Technologies for Alert and Notification Applications**

## **Social Media in Early Warning and Emergency Management**

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# Social Media

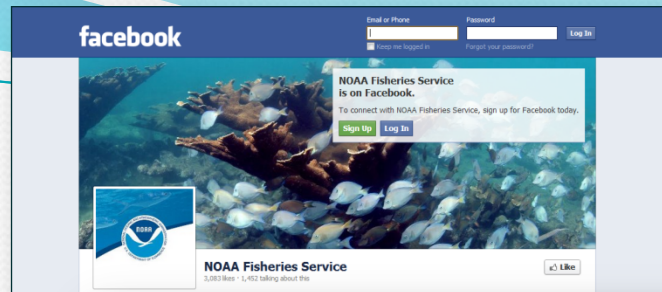
- Social media platforms are gaining wider consideration and attention for early warning and emergency communications
- Facebook around 1.39 billion Global monthly active users, a 13<sup>0</sup>% increase year over year (Source: Facebook as of 1/28/2015)
- Twitter (as of the 4<sup>th</sup> Quarter of 2014) reports that there are some 288 million monthly active users.





# Social Media

- In general there is little experience or research with using social media for alerting and emergency communications.
- Notionally, it appears worth engaging with these networks in a conservative way.
- Social media networks are probably best used for ‘broadcasting’ alerts, notifications, and updates. Applications that seek to get information from the public or enter into ‘micro dialogues’ are probably best left as research and should not immediately be considered part of emergency operations.







# **Communication Technologies for Alert and Notification Applications**

## **Extensible Data Formats**

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# Extensible Formats: RSS / Atom

- RSS (Real Simple Syndication) was developed as a way to distribution (syndicate) updated information streams such as news reports, however it has been widely used by meteorological services.
- Atom is another syndication format designed to address some limitations and development issues of RSS.





# Extensible Formats: CAP

- The Common Alerting Protocol (CAP) is another XML based data format concentrating on the exchange of warnings and emergency information.
- Intent is to ensure a warning / alert can be disseminated over multiple platforms while retaining message integrity.
- Created by the OASIS group and recognized by the ITU in recommendation x.1303.
- Promoted as part of WIS.



# **Communication Technologies for Alert and Notification Applications**

## **RANET Chatty Beetle**

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Kelly Sponberg**



# Chatty Beetle: What is it?

- The RANET Chatty Beetle is a text-based alert and messaging device designed by RANET for remote applications where other communications do not exist, are unreliable, or where a simple notification is needed. It is not designed to replace formal means of communicating alerts, but rather serves as a “heads up” notification.



# Chatty Beetle: What is it?

- RANET developed the Chatty Beetle in response to needs articulated by the Pacific Communications Steering Committee.
- It is built upon and uses Iridium Short Burst Data.







# Thank You!

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