When the Cell Towers Go Down

Situational Awareness After the Big One

ES-Link • Situational Awareness • LoRa Mesh • AREDN

An Introduction for Emergency Service Workers

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Today

- Presentation about a systems-level capability for emergency communications
- Not:
  - Scenario debate. One scenario is assumed.
  - Policy discussion. Keep policy and mechanism separate.
  - A suggestion of replacing “X” with “Y”
  - Plans of any specific community.

The HayWired Scenario: M7.0 on the Hayward Fault

- USGS HayWired Scenario — Scientific Investigations Report 2017-5013
- Magnitude 7.0 earthquake, epicenter beneath Oakland
- Projected impact: 800+ deaths, 18,000 injuries
- $82 billion in building damage across the Bay Area
- Fires, landslides, liquefaction compound the shaking damage
- Aftershock sequences continue for months

Source: USGS Scientific Investigations Report 2017-5013, Chapter S (Detweiler & Wein, eds., 2018)

Chapter S: Communications

⚠ Cellular networks lose 50% capacity within minutes

⚠ Full cell restoration takes 2–4 weeks

⚠ Internet service disrupted across the region

⚠ 911 call centers overwhelmed within seconds

⚠ Cloud-based tools (Veoci, etc.) become inaccessible

Today's presentation is not about scenarios that are **small scale** or **non-infrastructure impacting**

What Breaks When the Ground Shakes

Still Working

- Voice radios (VHF/UHF)
- AREDN mesh (mostly)
- Face-to-face
- Paper forms

Degraded

- Generator- and especially battery-powered repeaters
- Some internet (spotty)
- Landline phones (some)

Unreliable

- Cellular networks
- Internet / cloud services
- Veoci, WebEOC
- Email, SMS
- VoIP / Zoom

Voice radios give you voice. But how do you get a structured damage assessment — with GPS coordinates, severity ratings, hazard flags, and photos — from 50 BPCs back to the EOC in real time?

A Resilient Communication Solution in Three Layers

SA Server — EOC Dashboard

Real-time map • Triage & assignment • ICS-214 generation • Personnel tracking

Runs on laptop at EOC or staging area — no internet required

LoRa Mesh Radios over AREDN / OESNet

1–5 mile range per hop • Multi-hop • Long battery life

No infrastructure required — radios form the network themselves

ES-Link — iOS Field App

Offline maps • Damage assessment forms • Photo capture • Auto check-ins

Connects to mesh radio via Bluetooth — works without cell service

Think of it this way: Mesh replaces cell towers. ES-Link replaces paper forms.
SA replaces the whiteboard.

LoRa Mesh: Your Radio Network That Builds Itself

- Open-source networking firmware (Meshtastic, MeshCore, Reticulum)
- 915 MHz ISM band — no license required
- 1–5 mile range per hop; multi-hop can extend to 10+ miles
- Devices cost $25–$50 each (RAK, Heltec, LilyGo)
- Battery life: one to several days on a single charge
- 100,000+ devices deployed worldwide
- Carries data, not voice: GPS, forms, short messages

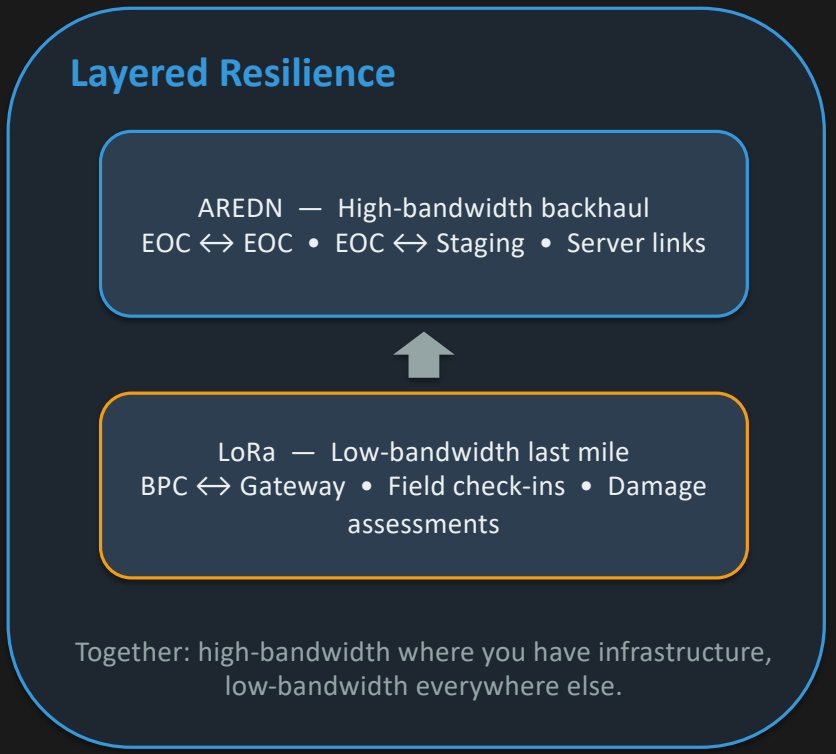
For hams:

- Think of it as packet radio's modern replacement
- It's meshable — no repeater infrastructure needed
- Your iOS device talks to it over Bluetooth
- Works alongside voice — doesn't replace it
- Complements AREDN for backbone + last mile

AREDN and OESNet: High-Bandwidth Backhaul

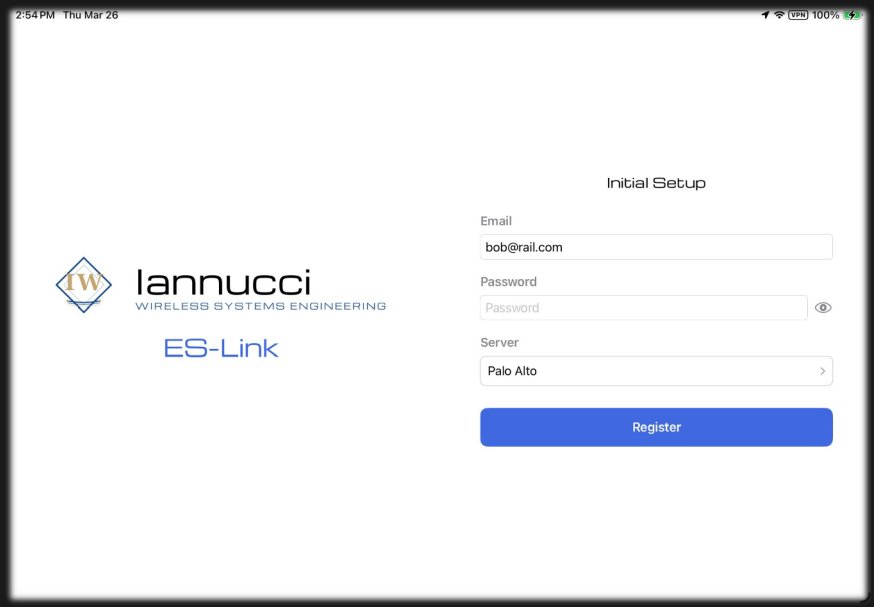
- AREDN: Amateur Radio Emergency Data Network
- WiFi-based using Part 97 (ham license required)
- Megabits per second vs LoRa's kilobits
- Connects EOCs, staging areas, hospitals
- Supports full SA dashboard access
- Video backhaul, file transfer, VoIP capable

- And its unlicensed twin OESNet, being built



Before the Disaster: You are Prepared

- Install ES-Link from the App Store (in beta test today)
- Get credentials from your NPC and log in
- App initializes itself with detailed maps of the City and surrounding areas
- No web-based maps or other web resources will be needed



It's Tuesday, 4:18 PM.
The Hayward Fault Ruptures.

You're a Block Preparedness Coordinator (BPC) in Palo Alto.

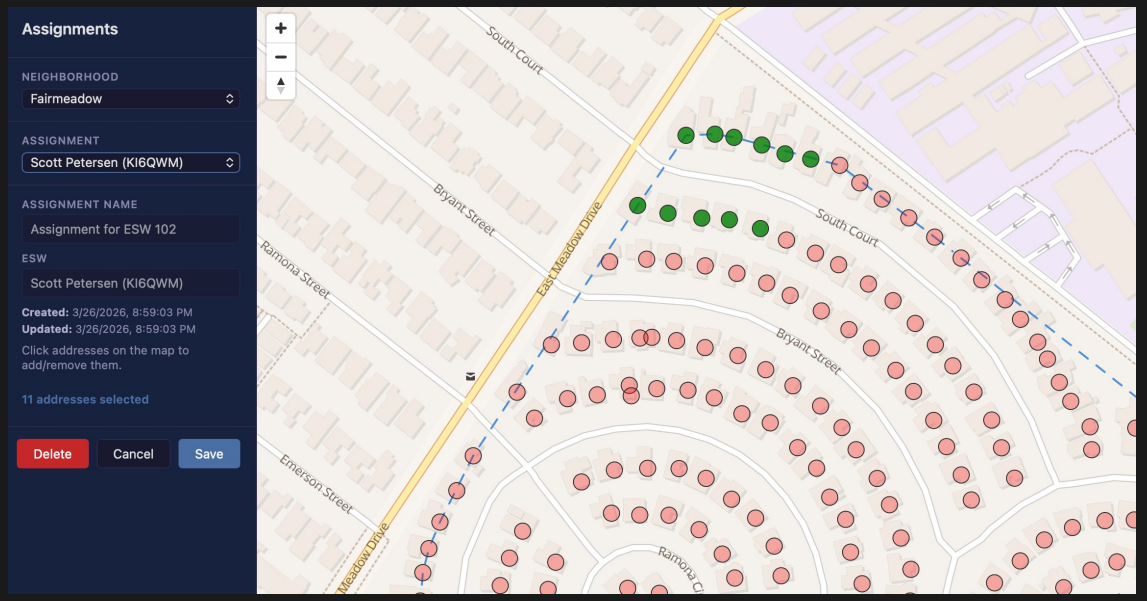
The shaking lasts 20–30 seconds. Things fall. The power goes out.
Your phone shows "No Service."

By 6:00 PM, your Neighborhood Preparedness Coordinator (NPC)
has set up a generator-powered laptop at the
neighborhood staging area with access to the SA portal.

Here's what happens, step by step.

Step 1: The NPC/DOC/EOC Create Assignments

- NPC logs into SA web portal
- Opens the Assignment Map tool
- Selects neighborhood → sees all addresses
- Assigns addresses to each BPC and ESV



Step 2: Grab Your Kit

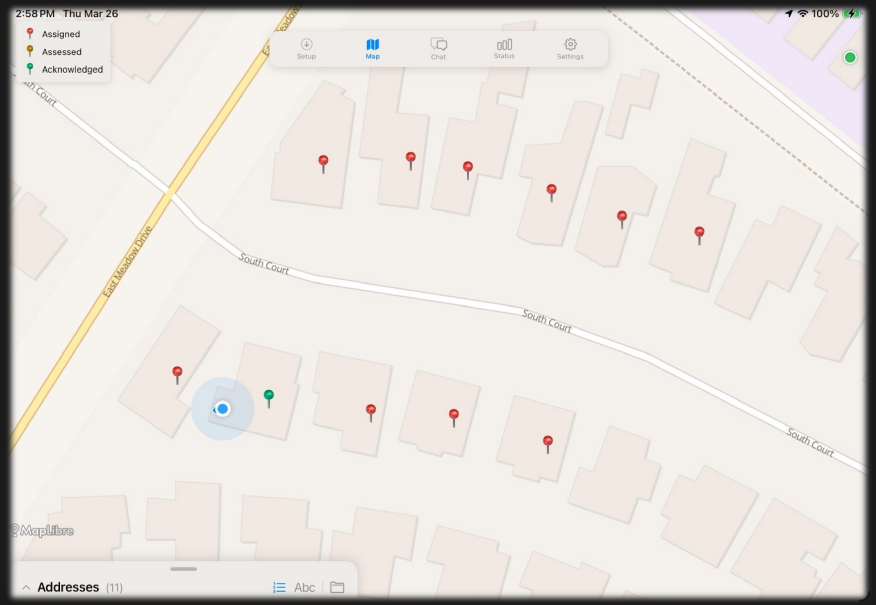
1. **iOS device (Android soon)**
   Pre-loaded with ES-Link and offline maps

2. **Mesh Radio**
   Clips to vest or pack, pairs via Bluetooth

3. **That's it.**
   No cell service needed. No internet needed.

Step 3: Your Addresses on the Map

- Download your assignment
  - Today: at any AREDN / OESNet access point
  - Soon: over-the-LoRa-Mesh
- Assigned addresses shown as colored pins
  - Red: not started
  - Yellow: assessment sent
  - Green: acknowledged by SA server
- Your GPS location = blue dot
- All maps render locally — no internet
- Tap a pin to start an assessment
- Sidebar shows address list + status



Step 4: Fill Out the Damage Assessments

Structural Damage
None / Light / Moderate / Heavy

Casualties
Trapped • Delayed • Immediate • Deceased

Fires
Count burning, count extinguished

Access
Accessible / No Access

Hazards
Gas • Water • Electrical • Chemical

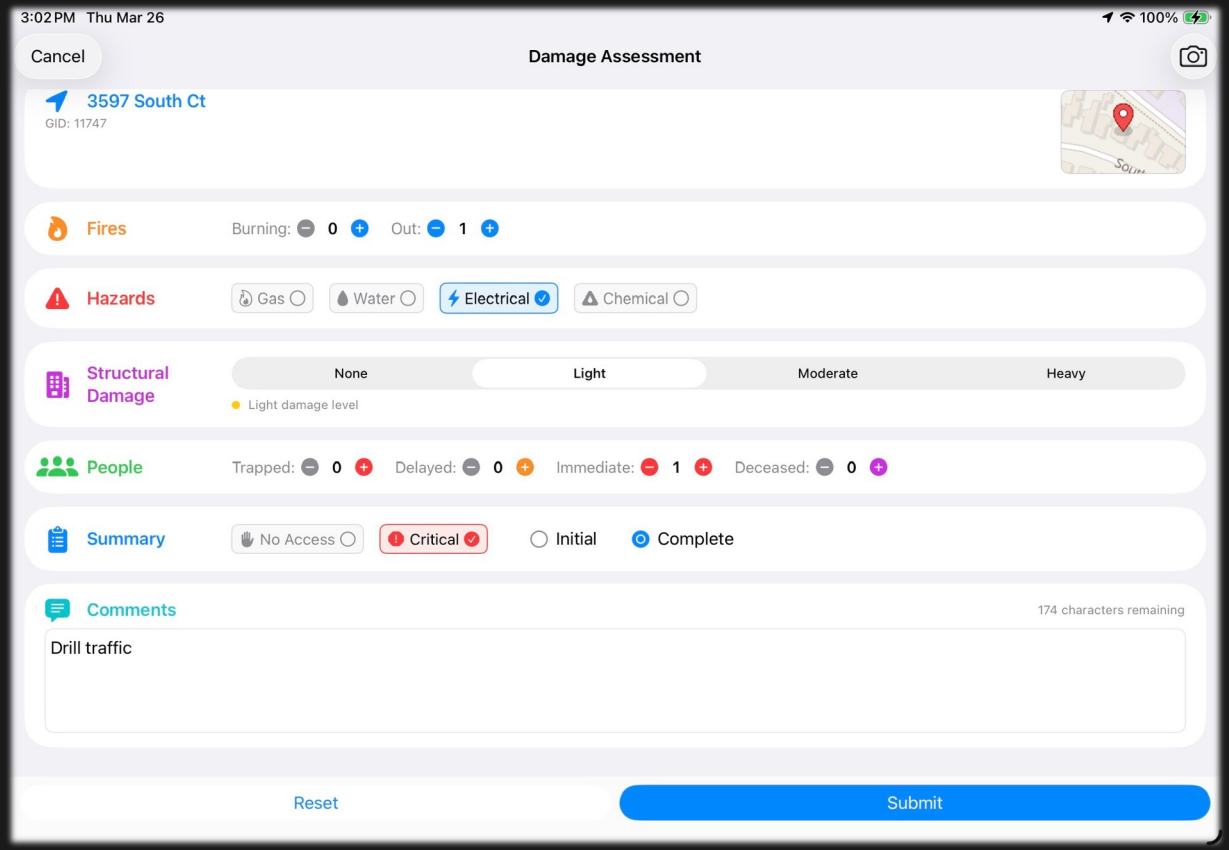
Photos
Camera captures geo-tagged images

Critical Flag
One-tap escalation for immediate attention

Comments
Free text for anything else

Same data as a paper CERT damage assessment form — but it transmits automatically when you hit Submit.

The Form on Your iOS device



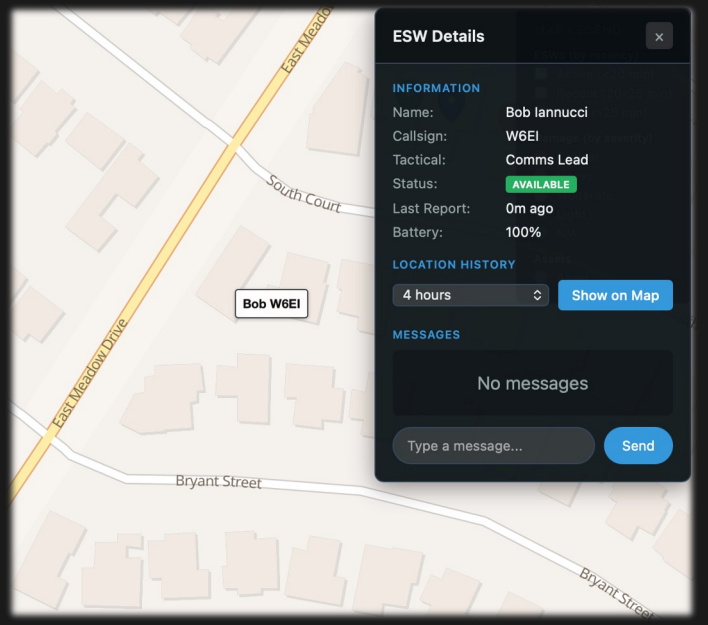
Step 4: Hit Submit — The Radio Does the Rest

← ← ← Acknowledgement returns over the same path ← ← ←

- Assessment compressed into a binary message (~100 bytes)
- If gateway is temporarily unavailable, message queues and retries automatically
- Acknowledgement confirms receipt — you know the NPC / DOC / EOC got your data
- Multiple transport paths: Mesh LoRa (primary), MQTT over AREDN
- Photos queue separately and send when higher-bandwidth transport is available

Step 6: Your NPC Always Knows Where You Are

- ES-Link automatically sends your GPS + battery level
- Triggers: move >50 feet OR stationary >20 minutes
- No action needed — runs silently in background
- NPC and EOC see your marker on the map
- Your name and callsign / tactical call show on the map
- Indicates how recent your last check-in was



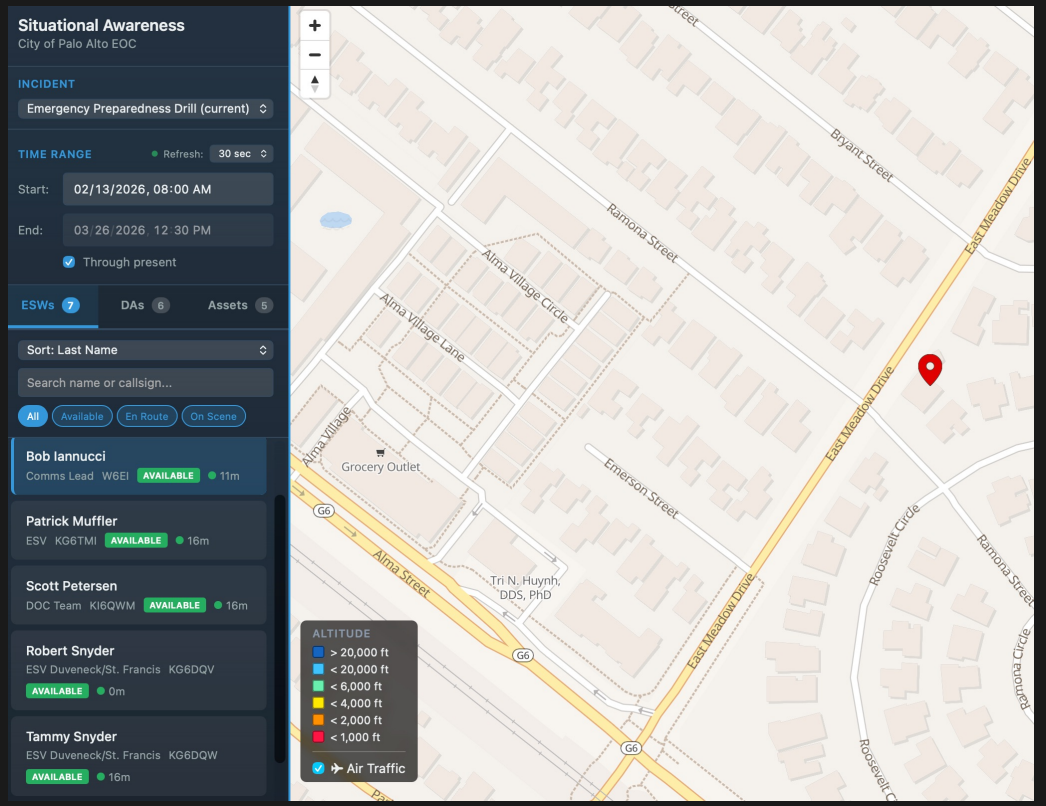
Meanwhile, at the

Emergency Operations Center

What the NPC and EOC professionals see
as your damage assessments arrive in real time

Real-Time Common Operating Picture

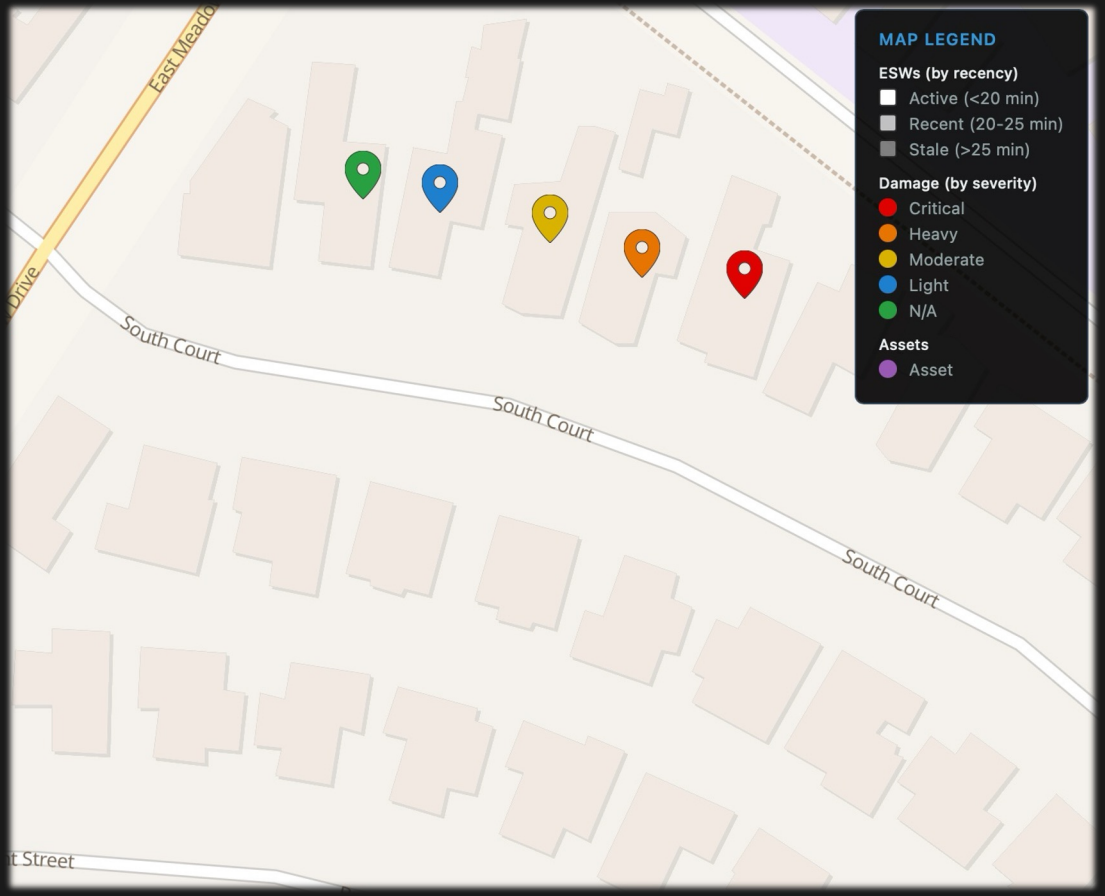
- Three-tab sidebar: ESWs | DAs | Assets
- Map: BPC/ESV locations and color-coded damage assessments
- Time range filtering
- Auto-refresh every 30 seconds
- Also: real-time air traffic (e.g., MedEvac)



Triage at a Glance

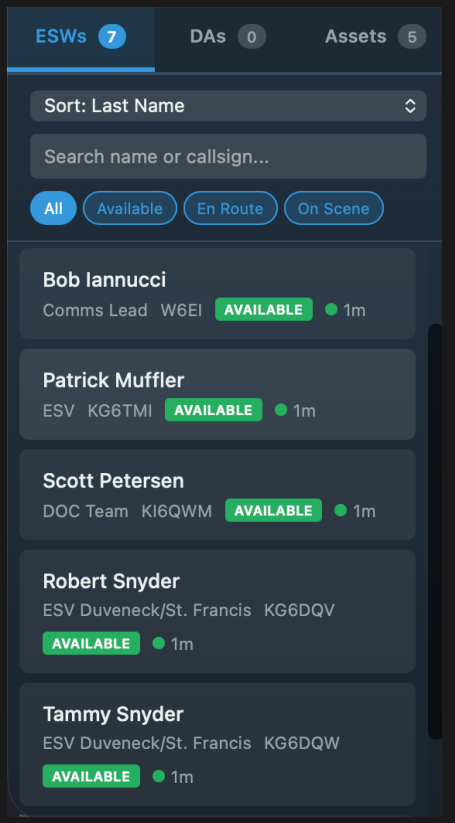
Severity Color Coding:

- Critical
- Heavy
- Moderate
- Light
- N/A



Personnel Accountability in Real Time

- Every field worker visible on the map
- Status: Available • En Route • On Scene • etc.
- Visually-coded recency
- Battery percentage of their LoRa mesh device
- Callsign and tactical designation
- Click any ESW → breadcrumb trail of movements
- Send messages directly from EOC to field



From Assessment to Action

1

Critical assessment arrives

"210 E Meadow Dr. — fire burning, water and electrical hazards, moderate structural damage. One trapped."

2

EOC professional reviews

Clicks assessment → opens detail popup with full data

3

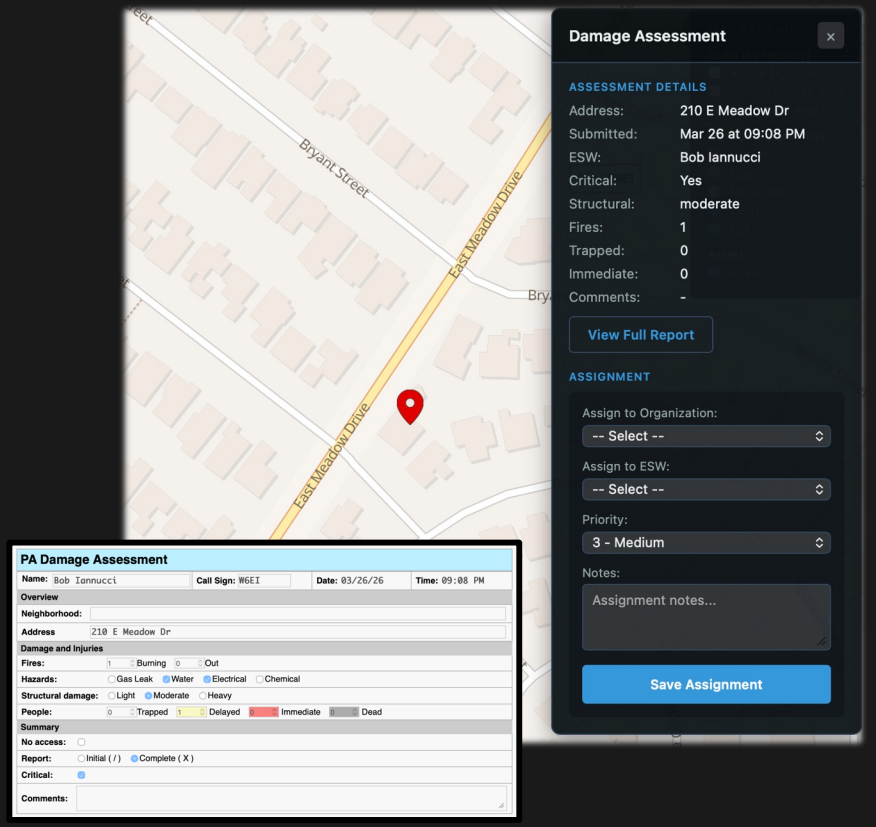
Assigns resources

Organization: Fire Dept • Priority: 1 • Notes added

4

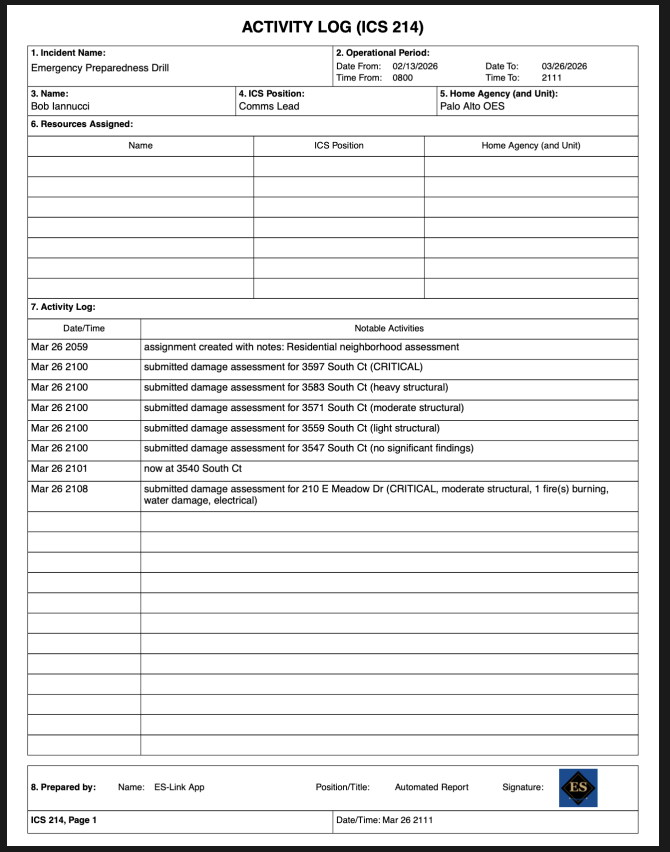
Dispatch message sent

Nearest available ESW receives instruction on their iOS device



Your ICS-214 Writes Itself

- SA automatically logs all field activity:
  - Check-ins, assessments, status changes, messages
- Generate ICS-214 Activity Log with one click
- Select ESW + time range → PDF downloads instantly
- NIMS-compliant format accepted by emergency management



ACTIVITY LOG (ICS 214)

1. Incident Name: Emergency Preparedness Drill	**2. Operational Period:** Date From: 02/13/2026 Time From: 0800	Date To: 03/26/2026 Time To: 2111
3. Name: Bob Iannucci	**4. ICS Position:** Comms Lead	**5. Home Agency (and Unit):** Palo Alto OES

6. Resources Assigned:

Name	ICS Position	Home Agency (and Unit)

7. Activity Log:

Date/Time	Notable Activities
Mar 26 2059	assignment created with notes: Residential neighborhood assessment
Mar 26 2100	submitted damage assessment for 3597 South Ct (CRITICAL)
Mar 26 2100	submitted damage assessment for 3583 South Ct (heavy structural)
Mar 26 2100	submitted damage assessment for 3571 South Ct (moderate structural)
Mar 26 2100	submitted damage assessment for 3559 South Ct (light structural)
Mar 26 2100	submitted damage assessment for 3547 South Ct (no significant findings)
Mar 26 2101	now at 3540 South Ct
Mar 26 2108	submitted damage assessment for 210 E Meadow Dr (CRITICAL, moderate structural, 1 fire(s) burning, water damage, electrical)

8. Prepared by: Name: ES-Link App Position/Title: Automated Report Signature:

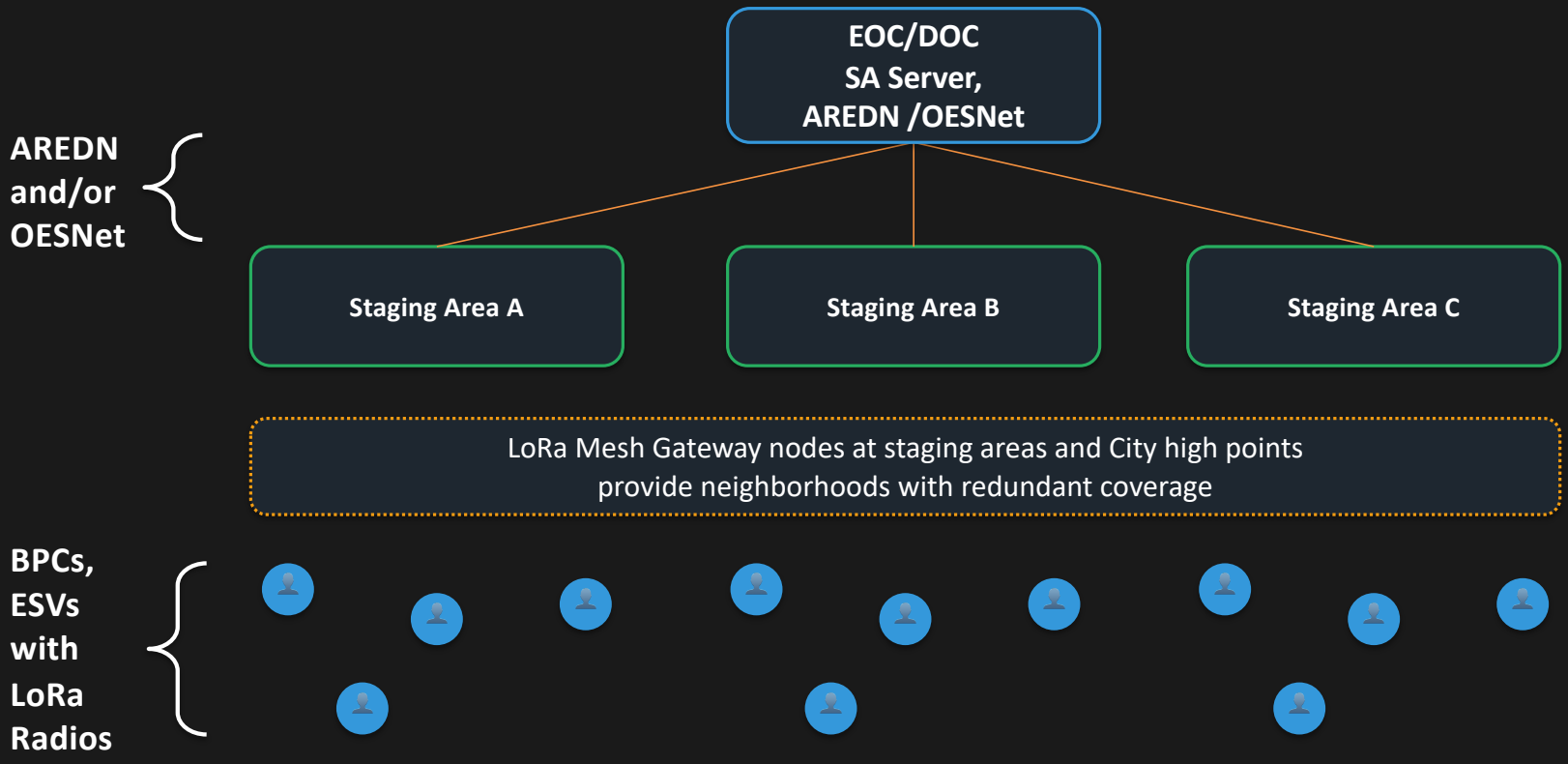
ICS 214, Page 1 Date/Time: Mar 26 2111

How It Compares to What You Know

Capability	Voice Radio	Veoci	SA + ES-Link
Works without internet	Yes	No	Yes
Structured data (not voice)	No	Yes	Yes
GPS tracking of field workers	No	Yes (cell)	Yes (resilient LoRa mesh)
Damage assessment forms	No (paper)	Yes	Yes
Real-time EOC map	No	Yes	Yes
Photo attachments	No	Yes	Yes
Automated ICS-214	No	Partial	Yes
Cost per user	$300+ radio	$$$/yr SaaS	$30-$50 radio + server + app

This doesn't replace voice radio — you still need voice for coordination.
This replaces the structured data flow that breaks when cell networks go down.

What the Mesh Looks Like in Your Neighborhood



What You Need to Get Started

- SA Server (demo server already installed at City Hall)
- ES-Link app (available to anyone as beta test SW)
- Backhaul network (AREDN already installed)
- LoRa Gateways (several already installed, need a few more)
- LoRa Mesh radio per field worker
- iPhone or iPad per field worker
- Laptop per staging area / NPC
- Laptop for EOC / DOC
- Training (2-hour session)
- Real-world drills
- Debrief / tune / improve

Ready in one afternoon

✓ Install ES-Link on iOS

✓ Load your address data

✓ Run a tabletop exercise

Questions?

Let's do a live demo

ES-Link • Situational Awareness • Mesh • AREDN
Open source • Free software • Built for communities

Beyond Damage Assessments

Additional ES-Link capabilities, the AREDN backbone,
and how you can help shape what comes next

ES-Link Chat: Messaging Without Cell Service

📣 Broadcast

Send a message to all ESWs on the mesh

"All BPCs: staging area relocated to Mitchell Park"

💬 Direct Message

Private message to a specific ESW

"KI6ABC: check the gas leak at 450 Loma Verde?"

🏘️ Neighborhood Channel

Group channel for a neighborhood team (future)

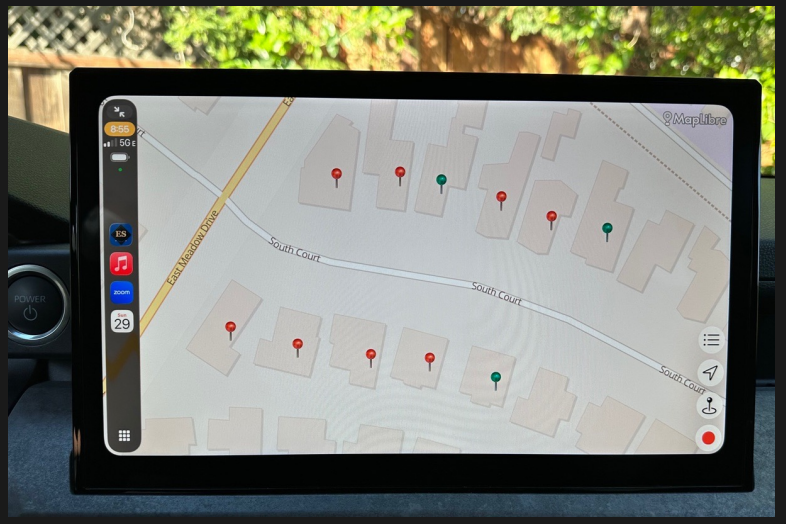
"All BPCs in Barron Park see the same conversation"

How it works

- Messages travel over the same LoRa mesh as damage assessments
- When AREDN or internet is available, ES-Link routes through MQTT for faster delivery
- Messages queue offline and deliver when connectivity is restored — nothing is lost

CarPlay: Windshield Surveys from Your Vehicle

- ES-Link supports Apple CarPlay natively
- See your assigned addresses on the car's display
- Your GPS position updates as you drive
- Perform rapid windshield surveys without stopping
- Health/welfare check-ins continue automatically
- Meshtastic radio stays connected



What's a windshield survey?

A rapid, drive-by assessment of an area — used in the early hours of a disaster to get a quick picture of damage extent before deploying on-foot BPCs/ESVs. CarPlay makes this nearly hands-free and keeps your eyes on the road.

Alerts: Not Every Disaster Announces Itself

The Alert Gap

Earthquakes are self-alerting — you feel them

But what about:

- A toxic chemical release upwind of your neighborhood
- A creek flood with minutes to evacuate
- A fire approaching your area at 3 AM
- An active threat at a nearby school

Without cell service, how does the alert reach you?

ES-Link + Meshtastic Alerts

Meshtastic radios beep when messages arrive

EOC can broadcast urgent alerts over the mesh

ES-Link displays alert messages with priority indicators

Works when cell networks and internet are down

⚠ Key Requirement

Your Meshtastic radio must be:

- Charged (battery lasts 2–5 days)
- Turned on (it's your emergency pager)

Keep it on your nightstand. It's your link when everything else goes dark.

The AREDN Network: More Than a Mesh Radio

Meshtastic → Kilobits/sec • Short messages • No license

AREDN → Megabits/sec • Full applications • Ham license

- Full SA portal access — same EOC dashboard, over radio
- Mattermost team chat with full keyboard input
- Can auto-relay messages to the mesh network
- File transfers and photo uploads at broadband speed
- Wiki for shared reference documents, modifiable real-time
- Print capability at staging areas
- Email between nodes (and beyond, in future)

📞 The "Bat Phone"

AREDN supports Voice over IP (VoIP) between nodes. Connect a desk phone or softphone and you have a direct phone line to the EOC — over ham radio, no cell tower or internet needed.

A dedicated hotline that works when nothing else does.

⌨ Type on a Real Keyboard

Meshtastic messages are short (228 bytes) and typed on an iOS screen. With AREDN, you can sit at a laptop and use Mattermost — full chat with channels, threads, file attachments, and search.

Short messages typed into Mattermost can be automatically relayed to the mesh so field workers receive them on ES-Link.

AREDN Nodes at Staging Areas

Why Every Staging Area Needs an AREDN Node

- The full SA portal is only accessible through AREDN
- NPC can manage assignments and view assessments
- Mattermost chat connects staging area to
  - the DOC / EOC
  - other staging areas
  - equipment trailers
- Display wiki page with latest info from the city
- Print ICS-214 forms and assignment sheets on site
- Photo uploads reach the EOC at broadband speed

Staging Area Equipment

AREDN node — WiFi radio on a mast or rooftop

Laptop — SA portal + Mattermost

Meshtastic gateway — bridges mesh ↔ AREDN

Generator or battery — powers the staging area

Printer (optional) — ICS forms, assignment sheets

Each AREDN-equipped staging area is a self-sufficient operations center. Even if the EOC goes offline, the staging area can continue coordinating its neighborhood. This is neighborhood resilience.

We Need Your Help: Refining the Interface

🤔 What Do You Prefer?

- Map orientation and zoom defaults
- Information density vs. simplicity
- Color coding that works for you
- Form field ordering and grouping
- Notification preferences

🧪 Hands-On Testing

- Tabletop exercises with the real app
- Field walkabouts with ES-Link + radios
- Stress-test with 10–20 simultaneous users
- Test in low-connectivity areas
- Night and wet-weather operation

👥 Why a User Pool Matters

- Developers can't anticipate field conditions
- Different roles have different workflows
- Real feedback shapes real improvements
- Your experience becomes the product
- Community-driven = built for you

If you want to participate in group exercises and help shape ES-Link, please let us know today. The more diverse our testing group, the better the tool becomes.