



Staff Sgt. Yaritza Tejada, section chief assigned to 2nd Battalion, 77th Field Artillery Regiment, Division Artillery, 4th Infantry Division, inputs firing data into an Advanced Field Artillery Tactical Data System (AFATDS) during a live-fire exercise supporting Ivy Sting 4 at Fort Carson, Colorado, Feb. 3, 2026. (U.S. Army photo by Spc. Samuel Brandon)

## PACE on Paper, Silence on the Gun Line:

### The Army's Struggle with Resilient PACE for Fires Coordination

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In the frigid Mojave Desert of Fort Irwin, California, during the winter of 2024, III Armored Corps (IIIAC) descended upon the National Training Center (NTC) for NTC Rotation 24-03, tasked with commanding the 1st Armored Division's groundbreaking "Division in the Dirt" exercise, a grueling test of large-scale warfare against a simulated peer adversary. As equipment rolled in and as the corps' Tactical Operations Center (TOC) activated, antennas rose, and expectations soared for seamless command-and-control across 1,200 square miles of brutal terrain. Yet, when the moment arrived to link the corps' network to the division's tactical internet—the digital lifeline for coordinating intelligence, fires, maneuver, and logistics—a critical network component at the corps level failed, leaving no voice, no data, no backup for four agonizing days. This wasn't just a glitch; it exposed a gaping wound in the Army's Primary, Alternate, Contingency, Emergency (PACE) communications concepts, where redundant communications, meant to be unbreakable, collapsed in a controlled environment. It was at this crucible that LTG Sean Bernabe, then commanding IIIAC,

issued a decisive call to action: fight as we are equipped—not as we wish to be—to force the Army to confront a hard truth: the current Modified Tables of Organization and Equipment (MTOE) network cannot handle the bandwidth demands of modern Large-Scale Combat Operations (LSCO). The U.S. Army's current PACE communications framework is critically flawed, demonstrating consistent failures in realistic training scenarios and recent conflicts. Despite modernization efforts, a reliance on fragile digital networks, inadequate training, and a lack of redundancy at the division and corps levels threaten fires coordination and overall operational effectiveness in LSCO. A fundamental overhaul—prioritizing rigorous rehearsals, standardized equipment, embedded technical expertise, and a cultural shift towards redundancy—is essential to ensure resilient command and control in contested environments.

#### Cyclical Failures to Modernized PACE

Across historical and contemporary operations, failures in redundant communications have led to catastrophic outcomes.

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From British radios isolating Arnhem Bridge in Market Garden (1944), to satcom and HF breakdowns during the Bravo Two Zero patrol (1991), to friendly fire at Nasiriyah (2003) due to failed FM and satellite links, each case underscores the operational cost of fragile PACE planning. These lessons remain urgent as modern formations face peer-level EW threats and contested networks. Over the past three decades, from 1996 to 2025, the U.S. Army's PACE communications framework evolved from analog rigidity to digital sophistication, adapting to the demands of multi-domain operations against peer adversaries. Legacy doctrine under *FM 24-1* relied on SINCGARS VHF radios, HF alternates, TA-312 wirelines, and runners, all simple but layered. The 2000s introduced WIN-T and satellite communications, enabling real-time data but exposing vulnerabilities to jamming and overreliance on commercial devices. The Joint Tactical Radio System (JTRS) sought interoperability but faced delays, leaving HMS radios to fill the gap in phased fielding. By the 2010s, *FM 6-02* reinforced digital integration with Nett Warrior, Iridium satcom, and anti-jam technologies. Today, Capability Set '25 brings 5G-inspired networks, intelligent routing, and low-Earth orbit satellites like Starlink—advancing modernization while reaffirming the need for analog-digital redundancy in contested electromagnetic environments.

### Where Units Fail

In fires and targeting operations, the core objective of PACE planning is to maintain uninterrupted firing capability across the entire area of operations. When fires communications are disrupted or denied, targeting loses its ability to generate effects, slowing maneuver tempo, desynchronizing units, and hindering logistics, ultimately jeopardizing both current and future

**Figure 1. IIIAC PACE for Digital Fires**

#### PRIMARY

##### Upper Tactical Internet

- Upper TI consists of SIPR or MPE networks (WIN-T, COTS)

#### ALTERNATE

##### HMS Radio (AN/PRC-158 or 162)

- PRC-158 has 2 channel capability—
  - MUOS & TSM
  - MUOS = beyond line of sight
  - TSM = mesh network
- MUOS has 3x modes of communication
  - Point-to-point (voice)
  - Point-to-net (data only, unicast)
  - Group (voice congerence)
- Secure communication interoperability protocol (SCIP) (voice using MSISDN#)
  - Mobile subscriber ISDN (MSISDN) provides radio to SVOIP (vice versa) capability

#### CONTINGENCY

##### High-Frequency (HF)

- Requires critical path analysis
- CPA plan built by G6—distributed to multiple nodes

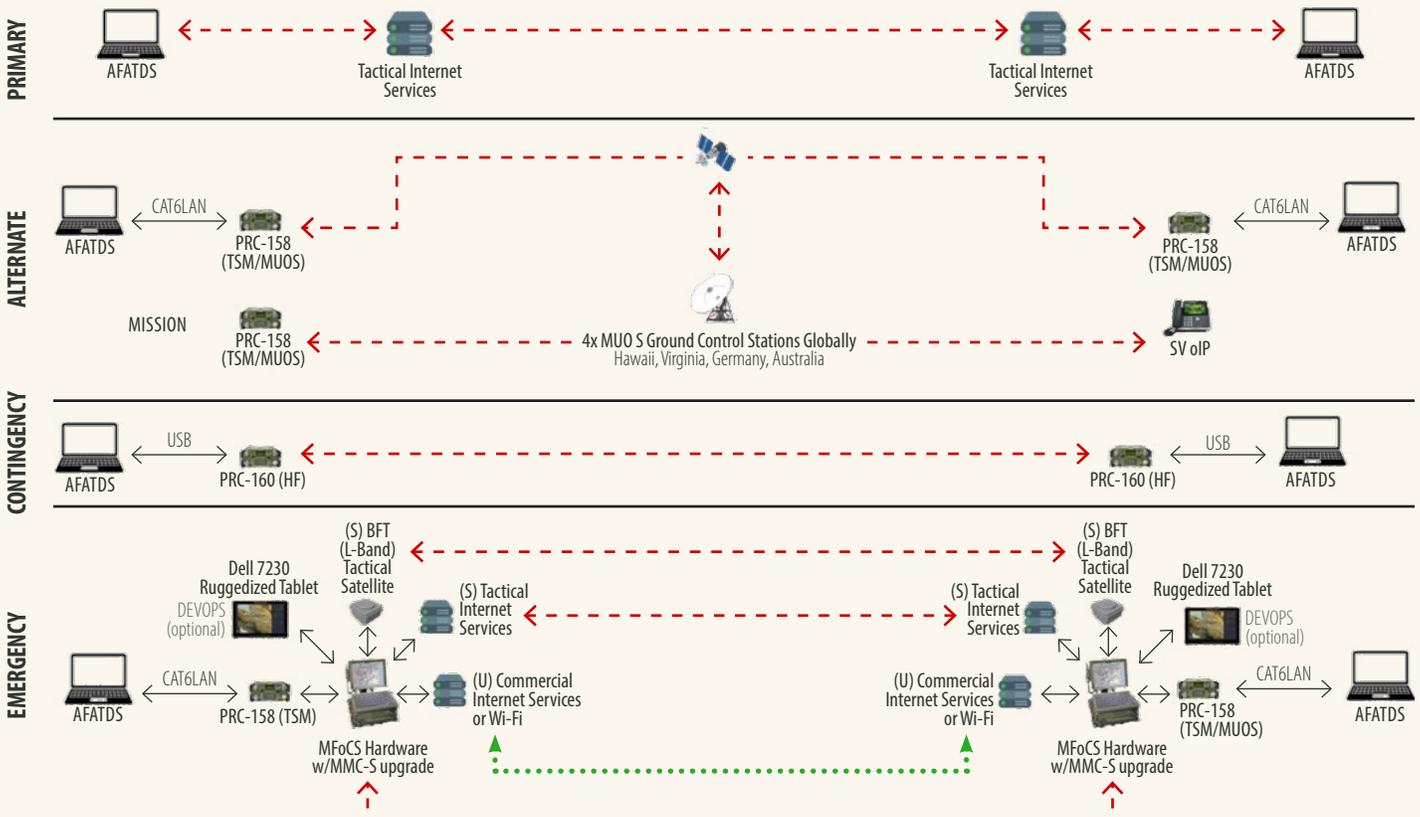
#### EMERGENCY

##### Mounted Mission Command—Software (MMC-S)

- Note: Requires software upgrade to MMC-S 3.1.1.0 on JBC-P hardware to leverage PACE option.*
- MMC-S has smart routing capability to select alternate transport methods—3x classified transports and 1x classified transport options
  - TOC kit = MFOCS basic
  - Vehicle kit = MFOCS intermediate
  - Ruggedized tablet offers enhanced user GUI and touchscreen operations
  - MMC-S serves as alternate fires cop

#### KEY:

- > Classified
- ...▶ Unclassified



operations. The reality is our PACE framework is routinely a “check-the-box,” risking complacency over adaptability, a problem compounded when PACE is isolated to a single network pathway. Treating all PACE systems as part of a single network eliminates true redundancy, compromising fallback options when the primary system fails. Insufficient practice with alternate and contingency systems—including HF radio adjustments and satcom bandwidth management—crippled responses during IIIAC’s LSCO scenarios. Insufficient training and experience prevent personnel from quickly transitioning to backup systems, mirroring past failures caused by procedural neglect. Overreliance on tactical internet systems—and the assumption they will survive electronic warfare—increases mission risk. This combination of poor planning, network vulnerabilities, inadequate training, and excessive digital dependence leaves fires C2 structures highly vulnerable in large-scale combat operations.

### **Fight Coms**

Units must operationalize weekly training and maintenance of communication systems. If vehicles are the focus of motor pool Monday’s, communications systems maintenance and training to employ them at distance to include over the horizon (OTH) must be the routine Tuesday. Developing TTPs and maturing expertise will close the historical gap in training, and familiarity will mitigate risk in high-stakes operations, especially in environments where satellite access is degraded or denied. Weekly maintenance of communication systems alleviates equipment challenges and identifies inconsistent system distribution; for example, a corps’ plan to use the AN/PRC-158 for MUOS transport as a fires network alternate fails if subordinate divisions haven’t received the radio, a common issue due to phased rollouts prioritizing other unit types. Without standardized equipment and rigorous, force-wide training on interoperability, PACE devolves into a patchwork of incompatible tools, risking silent gun lines and disrupted fires coordination when contested environments demand seamless fallbacks.

A critical gap in the Army’s PACE framework is multinational interoperability when tactical internet fails. No standardized multinational approach or process exists for PACE—leaving a critical gap in digital fires coordination, intelligence sharing, and maneuver synchronization when coalition networks fail. Current fallback methods—relying on liaison officers through SVOIP or chat—is slow, manpower-intensive, and vulnerable. Addressing this requires investment in both our own PACE capabilities and enhanced interoperability with allies, necessitating a review of data exchange protocols, cross-domain solutions, and potentially future systems procurement to ensure coalition effectiveness. Without pre-established procedures, shared frequency plans, and rehearsed communication protocols, coalition partners lose critical situational awareness during key operations. Therefore, PACE planning must actively integrate multinational capabilities using existing systems and sound doctrine, moving beyond reliance on liaison officer workarounds. Frequent rehearsals and risk-reduction events are essential to solidify data-exchange protocols and ensure seamless PACE implementation across coalition forces, preserving coalition unity when it matters most.

### **A Call to Action, Inflection to Change**

The 2022 Russian invasion of Ukraine exposed critical lessons for LSCO, particularly the imperative of mobility to evade adversary targeting, a challenge IIIAC has prioritized through its focus on targeting on the move. Fires and targeting leaders at the corps and division levels must embed mobility into their communications planning to maintain effective PACE frameworks. Ukraine’s experience with Russian electronic warfare (EW) highlighted the vulnerability of static formations with large electromagnetic signatures—amplified by digital systems—to signals intelligence and precision fires. In response, Ukrainian forces adopted a layered and adaptive communications strategy, blending military and civilian technologies (such as LTE networks, handheld radios, and mobile applications) to coordinate fire missions and synchronize battlefield effects. While these tools enabled tactical flexibility and localized coordination, their effectiveness was often constrained by bandwidth limitations and contested spectrum conditions. As U.S. formations begin integrating decentralized mesh networking, Proliferated Low Earth Orbit (pLEO) satellite communications, and Blue Force Tracking systems, their electromagnetic footprints expand, potentially exposing their positions to adversary exploitation. To counter this, IIIAC must institutionalize battlefield movement within its fires architecture, leverage mobile retransmission platforms such as UAS and rotary-wing assets, and train units to execute fires coordination on the move, ensuring resilient command and control in peer-contested environments.

The U.S. Army’s Next Generation Command and Control (NGC2) initiative and broader modernization efforts promise relief through emerging technologies such as AI-assisted network routing, 5G-inspired tactical networks, and low-Earth orbit satellite integration, enhancing PACE resilience for fires coordination in LSCO. However, as the Army transitions, expertise in legacy fires systems integration and interoperability is eroding, while older systems persist due to the phased fielding of new technologies like HMS radios with advanced waveforms and next-generation fires software such as the Artillery Execution Suite (AXS) and the Joint Targeting Integrated Command and Coordination Suite (JTIC2S). This creates a critical knowledge gap, where units must bridge aging infrastructure with modern demands, risking communications degradation when new systems underperform in contested, EW-rich environments. While significant effort is being placed on the C2 FIX initiative to address mobility and communication challenges at the brigade-combat-team level and below, PACE vulnerabilities remain largely unaddressed at division and corps levels. These higher echelons face unique challenges in synchronizing fires, maneuver, and sustainment across vast operational areas, where degraded or denied environments demand robust, scalable, and interoperable fallback communications, capabilities that C2 FIX does not yet extend to. Without deliberate investment in PACE solutions tailored for division and above, the Army risks reinforcing tactical connectivity while leaving operational-level command-and-control exposed to failure.

As the Army adopts Continuous Integration and Continuous Deployment (CI/CD) to accelerate software delivery across

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mission systems, it is concurrently shifting away from reliance on Field Service Representatives (FSRs) and toward centralized Software Support Services. While this modernization enhances agility and streamline updates, it introduces a critical gap in on-site technical expertise, particularly in the hardware-software integration essential to the fires architecture. Systems such as the Advanced Field Artillery Tactical Data System (AFATDS) and Forward Observer Software (FOS) platforms like Precision Fires-Dismounted (PF-D) application rely on synchronized sensor-to-shooter workflows and require real-time troubleshooting and configuration support that remote models often cannot provide. In the absence of embedded technical personnel, units face increased risk of degraded operational tempo and reduced responsiveness in high-intensity environments where fires coordination is mission-critical. To mitigate this gap, IIIAC has begun integrating Digital Fires System Engineers (DFSEs) sourced through Command, Control, Communications, and Applications (C3A) Solutions—a veteran-owned firm specializing in digital fires systems integration—to augment the loss of FSRs who historically delivered essential software, network, and integration support for fires systems. This collaboration has proven instrumental in restoring critical capabilities during high-tempo operations, and IIIAC is now exploring more enduring contracting mechanisms with C3A Solutions to institutionalize this support and ensure persistent technical overmatch across future rotations.

C3A Solutions represents a critical step toward restoring embedded fires integration capability, but additional measures will be required once the requirement is formally resourced. Sustaining operational overmatch demands more than ad hoc support; it requires a persistent, embedded integrator who operates from Corps HQ, travels to subordinate units, and actively supports PACE planning, system configuration, and cross-platform troubleshooting. As the Army transitions to CI/CD and centralized software services, IIIAC must ensure that hardware-software integration, tactical responsiveness, and fires system continuity are not compromised. This effort also demands a return to disciplined, weekly digital sustainment training at echelon, reminiscent of the mid-1990s when we trained for war with the USSR and treated fires systems as critical warfighting tools. It further requires close tracking of inoperable hardware and software that could disrupt the sensor-to-shooter kill chain and the establishment of direct feedback loops to influence modular changes in emerging technologies, ensuring soldiers are not left operating ineffective or unresponsive systems. To institutionalize this rigor, we must elevate the role of Digital Master Gunners within DIVARTY/FA Brigade headquarters and establish formal requirements for DMGs at other echelons. These experts will drive technical readiness, reinforce fires system prioritization, and ensure continuity across rotations, making digital fires a central pillar of operational success.

### FROM C3A SOLUTIONS PRODUCT BROCHURE

## Empowering Joint Fires and Targeting Excellence

C3A Solutions provides critical support for tomorrow's joint fires and targeting professionals, elevating mission success for commanders at all echelons. Our Digital Fires Systems Engineers are experts in loading, configuring, and maintaining tactical radio systems to enable PACE, while seamlessly integrating legacy and emerging fire support technologies to sustain the sensor-to-shooter kill chain. Through targeted over-the-shoulder training and Smallgroup instruction, we ensure operational readiness across platforms like AFAIDS/AXS, PF-D/PF-M, and MMC-S. Leveraging innovations such as OBERON and WinTAK, we drive strategic advantage and empower a highly skilled workforce to meet the demands of modern warfare.

### Services Provided

- **Over-the-Shoulder Technical Assistance:** Expert, hands-on assistance for fire support, targeting, and mission command software and hardware platforms, ensuring seamless operation and mission success.
- **On-Site and Telephonic Support:** Comprehensive assistance for setup, maintenance, and troubleshooting.
- **FSC2/Radio Troubleshooting:** Expert resolution for communication issues across all supported systems.
- **Loading Mission Plans and Software on ITN Radios:** Efficient configuration for operational readiness.
- **Digital Communication Support:** End-to-end sensor-to-shooter integration, including MFCS and tactical radio platforms; PACE planning to support operations.
- **Laser Range Finder Integration with PF-D/PF-M:** Seamless incorporation for enhanced targeting precision.
- **DAGR/DAPS Integration with PF-D:** Optimized alignment with digital fires architecture.
- **Weapon Locating Radar:** Assist with communications setup, configuration and integration into the digital fire support architecture.
- **3-5 Day Digital Sustainment Training Package:** Tailored instruction to ensure long-term proficiency.
- **Related Fields of Expertise:** Integration of WinTAK/Net Warrior, Integration of UAS emerging technology, Link-16 and fires integration, Starlink as a transport.



Figure 2. World Map from Vemaps.com

#### C3A Headquarters

3210 Ray Rd.  
Spring Lake, NC 28390  
(910) 235-1977 (Signal)

#### C3A Hub

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Fort Hood, TX 76544  
(254) 661-8948 (Signal)

#### C3A Help Desk

C3A-Support@C3Asolutions.com

## Recommendations for Resilient PACE Implementation

To overcome persistent PACE shortfalls and ensure resilient fires coordination in LSCO, the Army must overhaul planning, training, and culture. The following recommendations address systemic gaps exposed in NTC 24-03 and recent conflicts:

- 1) **Institutionalize PACE Rehearsals and Validation**
  - Conduct full-layer transitions (P/A/C/E) under degraded and EW conditions.
  - Require pre-mission checks of system interoperability, frequency plans, and fallback procedures.
- 2) **Stress-Test Early and Often**
  - Design exercises to degrade primary systems from Day 1, forcing use of alternatives and contingencies to expose training and equipment gaps.
- 3) **Standardize Equipment and Training Across Echelons**
  - Synchronize fielding of emerging technology across formations.
  - Train all units on waveform interoperability and legacy-to-modern system transitions.
  - Institutionalize a coalition-ready PACE framework using fielded systems, shared frequencies, and rehearsed data/voice exchanges.
- 4) **Develop Advanced PACE Certification Tracks**
  - Create hands-on training for signal officers, fire supporters, and battle staff across legacy, modern, and low-tech systems.
- 5) **Integrate Fires Mobility into Doctrine and Training**
  - Train units to coordinate fires on the move using mobile C2 nodes, dynamic targeting workflows, and mobile relay platforms (UAS, rotary-wing, ISR).
- 6) **Embed Technical Expertise at the Point of Need**
  - Sustain a hybrid model of centralized Software Support Services and embedded Digital Fires System Engineers (DFSEs) to bridge CI/CD delivery with battlefield execution.
- 7) **Leverage COTS Technologies for Redundancy**
  - Explore proven alternatives like BATS-Dv2, Starlink, Kymeta u8, and MANET mesh systems to strengthen alternate and contingency layers.
- 8) **Reinstate Weekly Digital Sustainment Training**
  - Conduct echeloned maintenance and training to reinforce PACE system proficiency, configuration discipline, and operator confidence OTH and at distance.

### 9) Track System Failures and Close the Feedback Loop

- Establish direct feedback loops with developers to influence modular updates based on soldier input.

### 10) Codify and Elevate Digital Master Gunner Roles

- Require DMGs at DIVARTY/FA Brigade HQ and echelons above brigade to institutionalize technical readiness and fires system prioritization.

### 11) Balance and Develop Multi-National Interoperable PACE

- Establish and codify enduring multinational PACE, enhancing interoperability through the exchange of data.

### 12) Make PACE a Leadership Metric

- Include PACE execution in AARs, command inspections, and evaluations to drive accountability and cultural change.

## Conclusion

The U.S. Army's next fight will not be won by technology alone: It will be won by the ability to command and coordinate fires under pressure, in environments where networks fail, satellites are jammed, and every transmission risks detection. The PACE framework, once a doctrinal afterthought, must now become a warfighting imperative. To prevail in LSCO against peer adversaries, the Army must institutionalize rigorous PACE training, enforce interoperability, and foster a culture that values redundancy as a combat multiplier. By embracing emerging technologies—AI-driven routing, LEO satellite relays, and mobile retransmission platforms—and pairing them with disciplined planning and decentralized execution, the Army can transform PACE from a paper checklist into a battlefield advantage. Two years ago, the IIIAC FSE began developing Targeting on the Move capabilities, focusing on a robust and survivable PACE across multiple communication pathways. Ongoing operations, exercises, digital sustainment training, and system evaluations—informed by Army Transformation Initiatives (ATI) and Transformation in Contact (TiC)—continue to modernize our ability to communicate effectively. Our continued focus will ensure we maintain the ability to execute both deliberate and dynamic targeting, delivering joint effects and achieving victory in LSCO. The cost of failure isn't just silence on the gun line; it's mission failure, lost tempo, and risk to both mission and force. A revitalized PACE approach requires our immediate and focused attention now.

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*Chief Warrant Officer Five Abel Almanza Jr. is a Senior Field Artillery Targeting Technician for III Armored Corps, bringing over 30 years of dedicated service to the field artillery community. Throughout his distinguished career, CW5 Almanza has held a multitude of Targeting Officer positions at both the tactical and operational levels, providing critical support to garrison and combat operations. His expertise is further enhanced by a Master of Science in Strategic Leadership from Charleston University and his completion of the Warrant Officer Senior Staff Education Course.*