WildfireDLN

Wildland Fire Data Logistics Network (WildfireDLN)

An Implementation of Resilient Networking

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PSCR

NIST PSCR Program

PSCR

Crosscutting:

- Security
- Resilient Systems

https://www.nist.gov/ctl/pscr/about-pscr

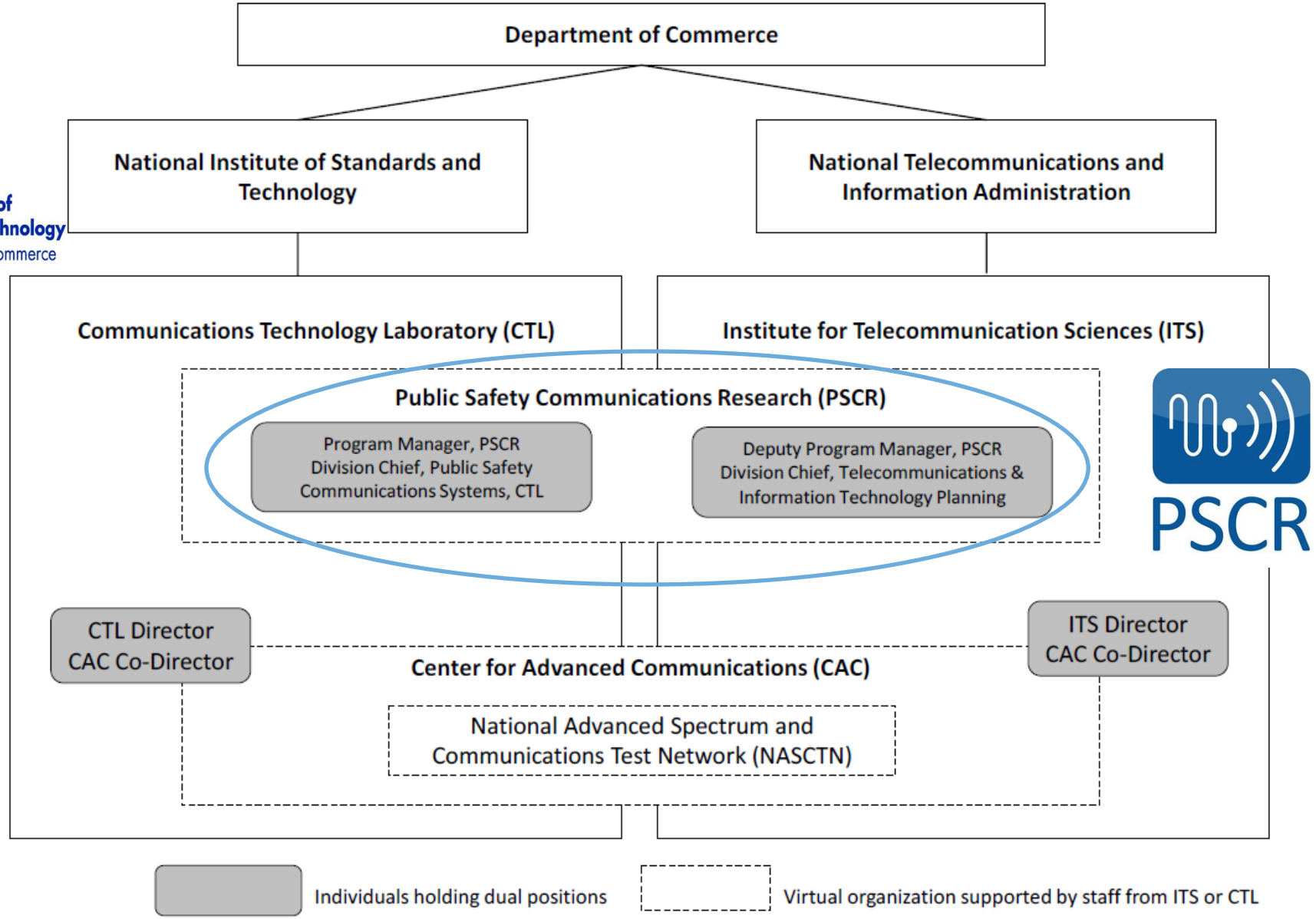


FIGURE P.1 The Boulder telecommunications laboratories.

Problem Statement

Wildland firefighting operations face challenges due to:

- Network coverage
- Data portability

As a result, incident command decisions and wildfire containment are delayed, possibly contributing to:

- Human illness & injury, including deaths
- Environmental impacts
- Property damages

Above: Incident Command morning briefing (National Park Service Photo)

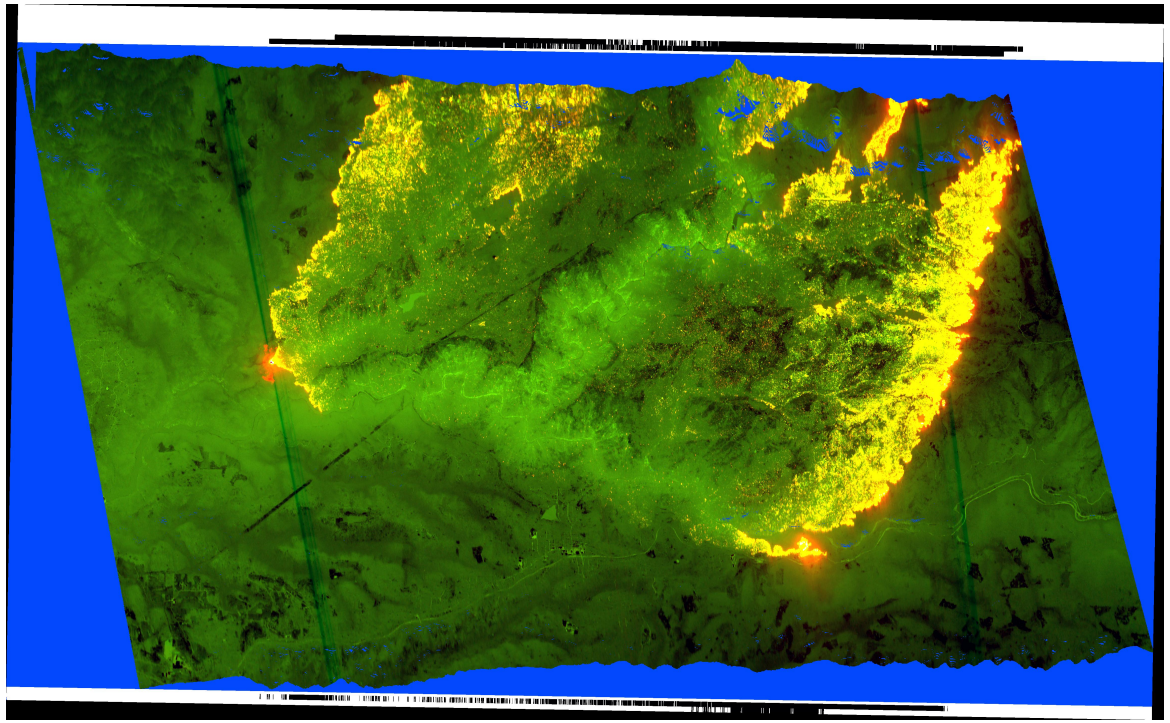
Left: Excessive post-fire erosion from the Hayman Fire (Photo by Mary Ellen Miller)

Project Motivation

Problem: ***Access to large, high-value data files can be limited in different ways.***

Users experience:

- Transfer of large data (e.g. satellite imagery, video) is slow
  - Insufficient bandwidth
  - Manual process
- Transfer large data is not possible
  - Insufficient bandwidth/storage
- All data transfers are not possible
  - limited/no connectivity due to:
    - Infrastructure damage
    - Power limitations
    - Insufficient cell tower coverage



Above: NIROPS image of the King Fire in Pollock Pines, CA.

Spaceborne & airborne systems routinely provide large data for decision support.

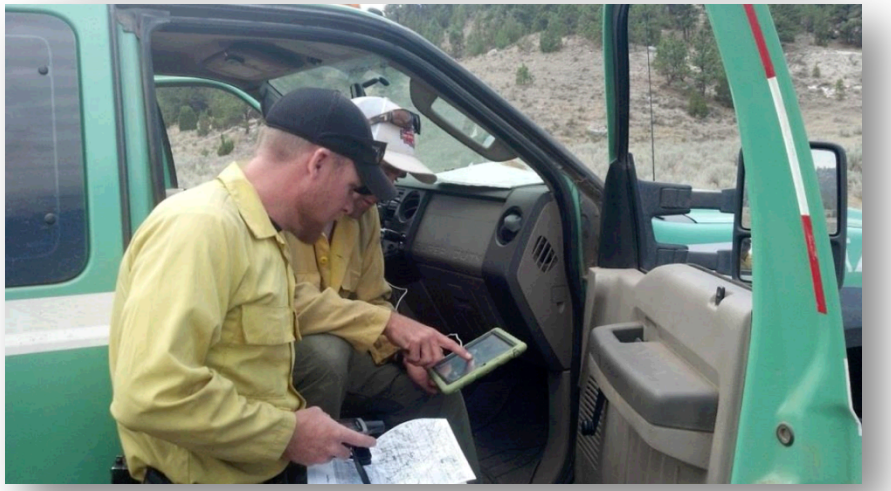
Solution

Solution: ***Develop software tools for data logistics based on existing resources, including future proofing.***

Deploy and test a prototype hardware-software system that:

- Demonstrates automated data ferrying with seamless user experience
- Integrates the new data sharing system with existing capabilities and relevant data.

Design and develop an asynchronous and heterogeneous data system.



System Overview
The Wildland-fire Data Logistics Network

Data Ferrying - now

Limitations of existing solution:

- Manual
  - Physical transport
  - Manual data manipulation
- Swapping iPads in the field (as opposed to transferring data)
- Connecting cables and wires
- “Namespace integration”
  - Where to place/store/recover files -> requires consistency
- Data corruption during transfer
  - Incomplete downloads

Amazon Web Services Snowmobile data ferry (100PB capacity)

IPads must be manually swapped or synced in the field (32GB – 128GB)

Data Ferrying - WildfireDLN

WildfireDLN :

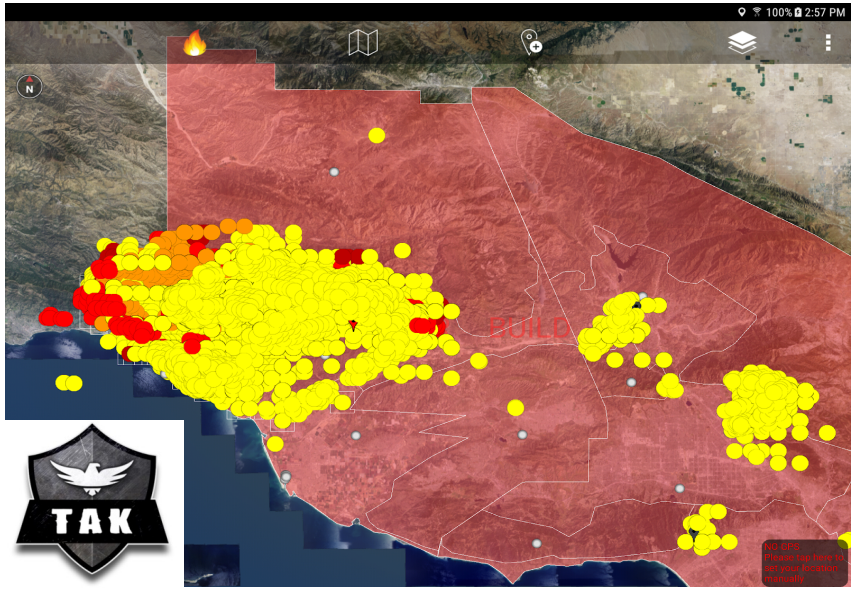
- High-performance wireless
  - Low-power signaling
  - To turn on the high-speed wireless when needed (for power conservation)
- Automated/integrated connectivity
  - “Always there with delay”
  - But delay is ok! -> (e.g. text messaging)
    - We think of it as always there and peer-to-peer
    - But it is in fact delayed and server-based

The key: seamless user experience

User Experience

Improving user experience is a fundamental project goal.

- Fully automated transfer of data
  - Detection of corruption
  - Re-transmission
  - View-consistency
- ATAK interface
  - Fully developed
  - User-tested
  - Flexible for development
- Potential for two-way data sharing (duplex communication)



System Architecture

Ferry build	Mobile build
Raspberry Pi 3-based ferry servers 	Mobile integration with Android frontend 
4G LTE or 801.11 WiFi communications  	4G LTE, 802.11, FirstNet connectivity   

System Architecture

Web-dlt

- User facing web page

IDMS

- Data manager

Periscope

- Metadata storage database

IBP

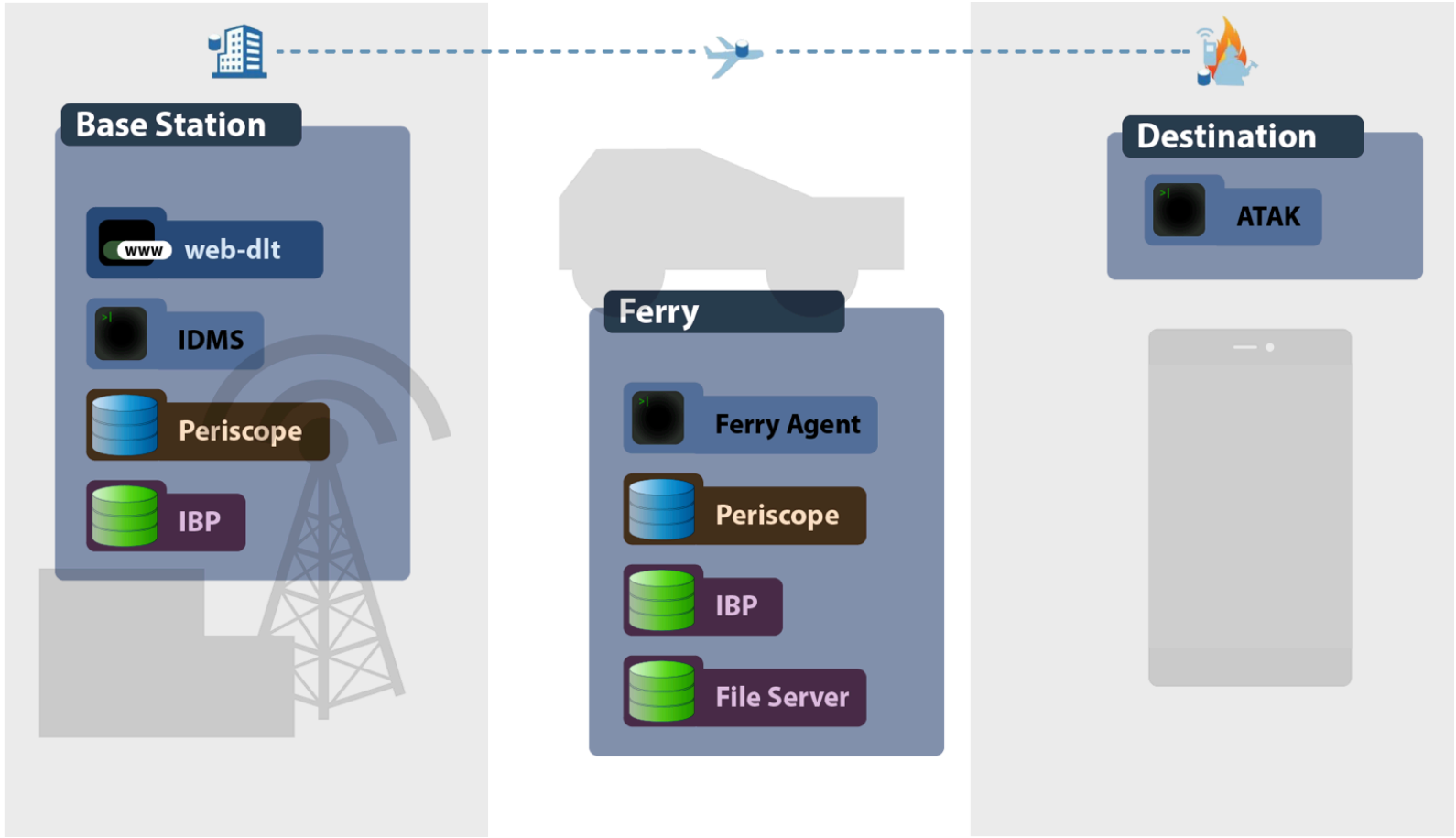
- Block data storage

File Server

- Web Mapping Service (WMS)

ATAK

- Mobile data client

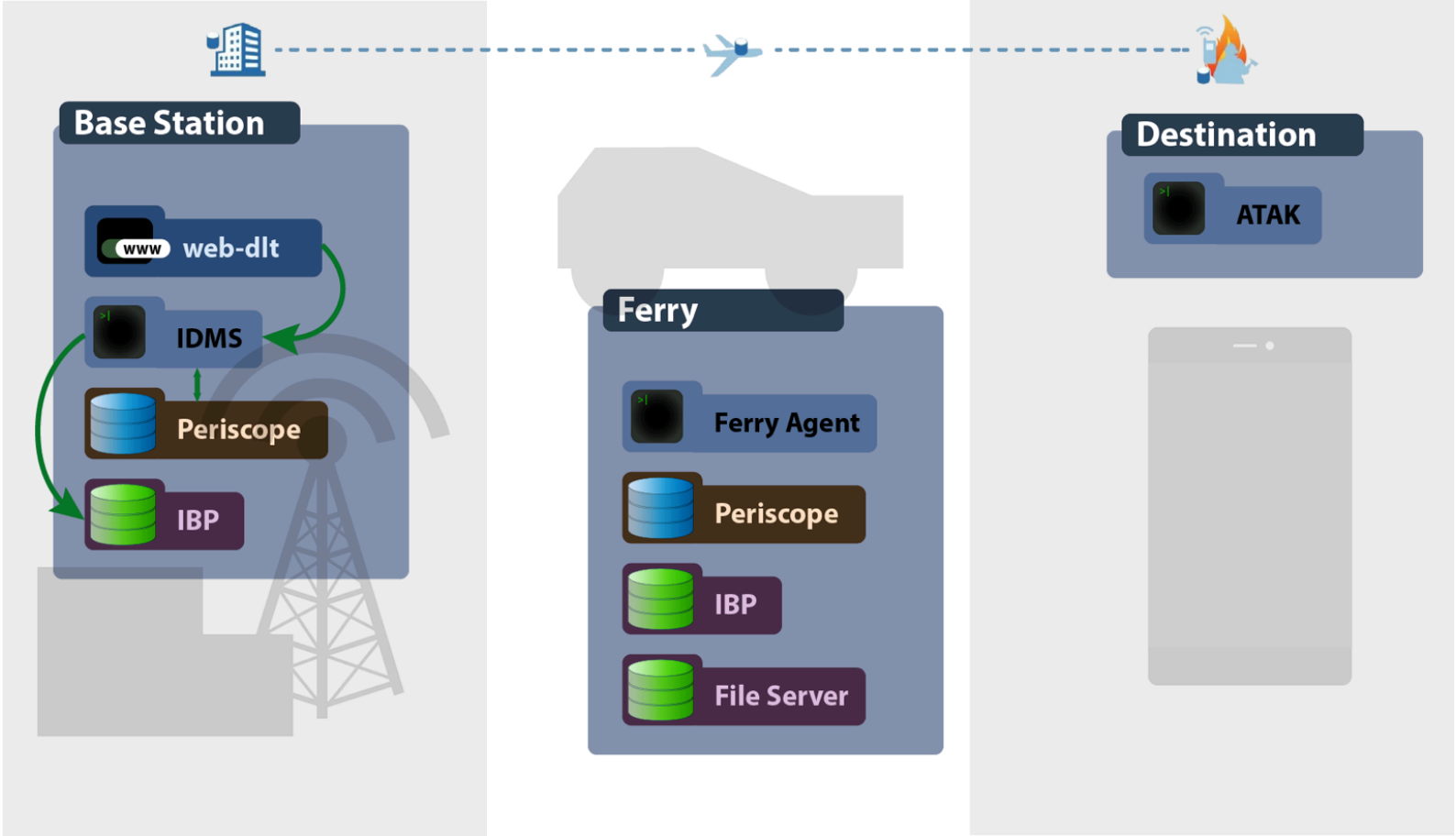


Data Request

Coordinator selects file to be sent to specified locations using the web-dlt webpage.

IDMS prepares the data for distribution:

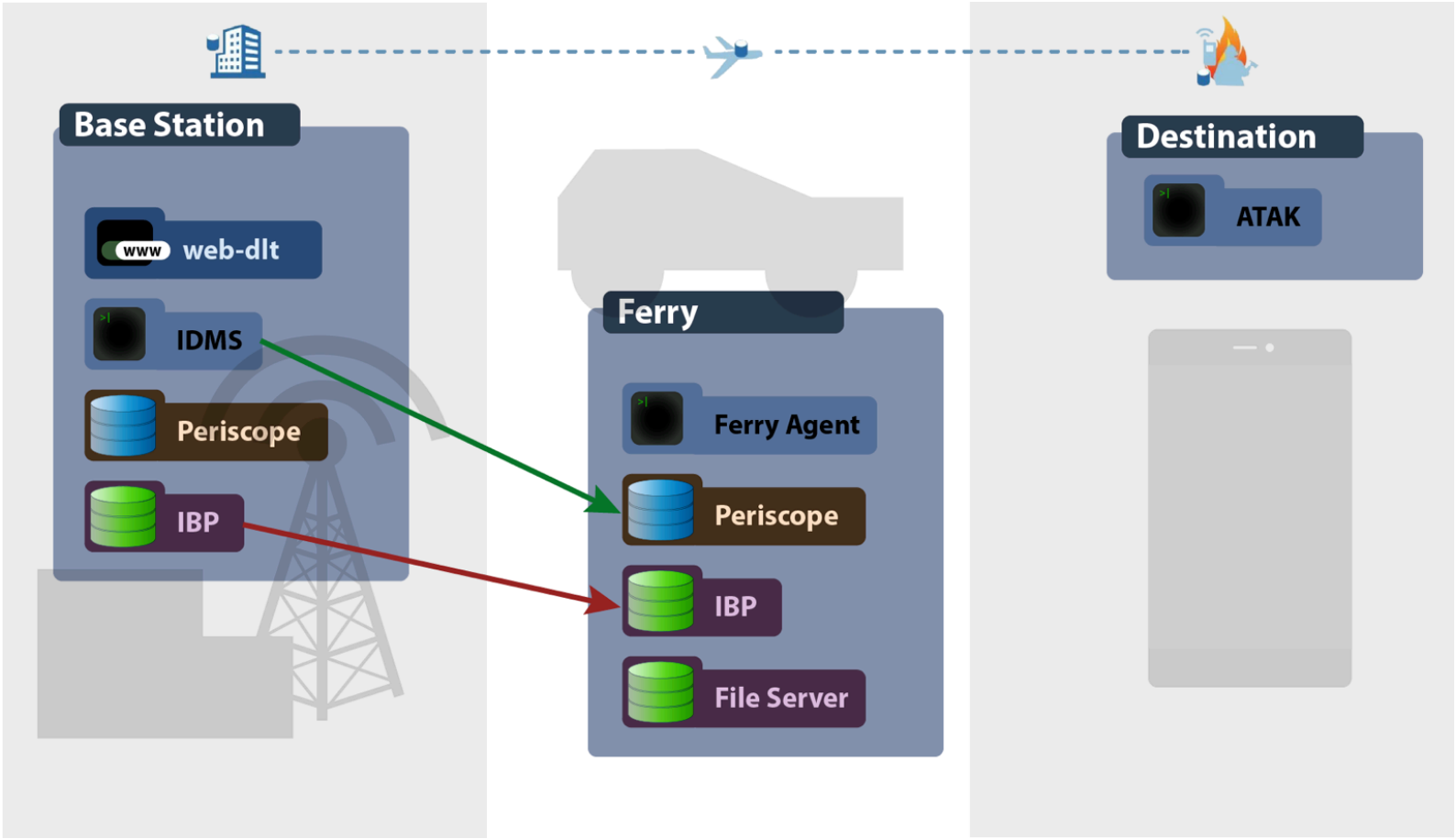
- Records the request for bookkeeping.
- Uploads the data to IBP, possibly from distant networked sources.



Data Transfer

After IDMS detects a ferry bound toward the destination:

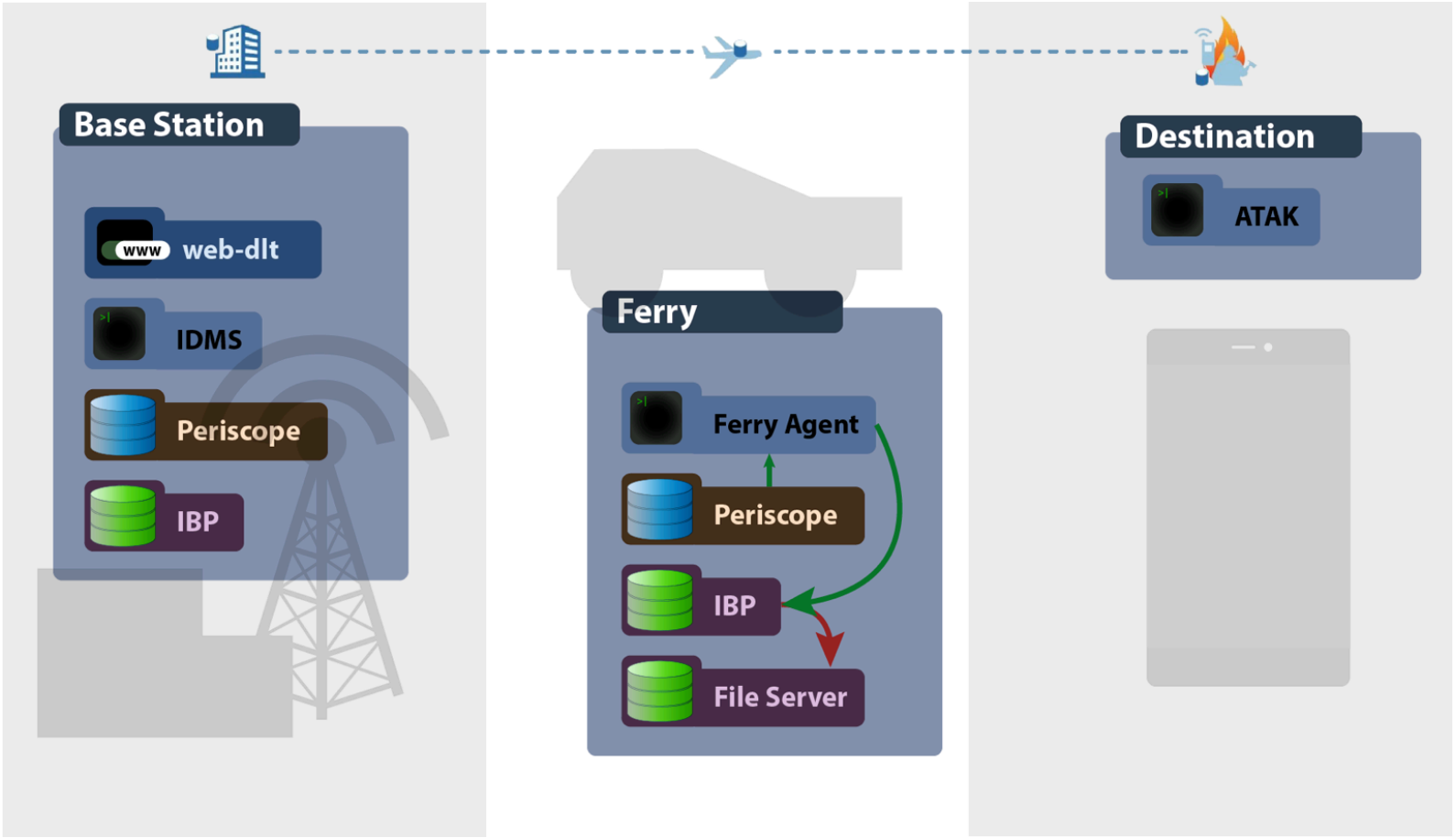
- IDMS records the transaction onto the ferry.
- IBP transfers the data onto the ferry.



Ferry Enroute

While the ferry travels:

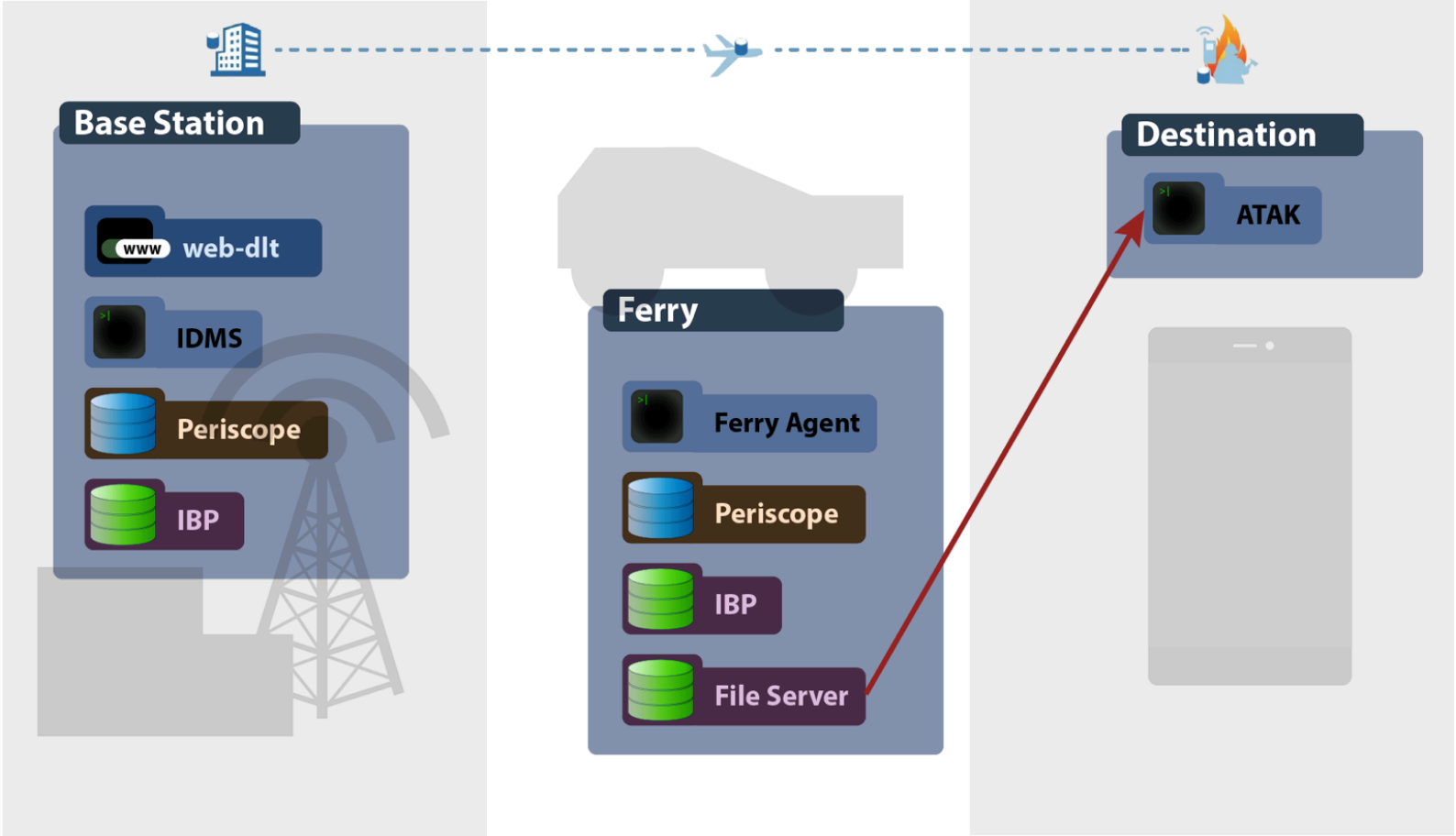
- The ferry agent downloads all data placed into IBP into a local file server.
- File server is available for external downloads.



ATAK Download

When the destination detects the ferry's local WiFi:

- ATAK automatically downloads all new files available on the ferry's file server.



Prototyping Scenarios

Deploy and test prototype hardware-software system with fire operations personnel that integrates the new data sharing system with existing capabilities and relevant data.

State of Colorado Center of Excellence for Advanced Technology Aerial Firefighting (CoE):

- Development of ATAK-based data access
- Improve current workflow for firefighters to access relevant geospatial data

COLORADO
Center of Excellence for Advanced Technology Aerial Firefighting
Department of Public Safety

National Interagency Fire Center (NIFC):

- Develop an intelligent data ferrying system
- Improve current methods of moving large data to on-site systems

Prototyping Scenarios

How can fire community help?

- Define requirements of an enhanced data sharing capability
- Provide resources for prototype development
- Engage in testing and evaluation of prototype and future system characteristics

Vision for the WildfireDLN

Current Scenario	DLN Vision
Moving files to the IC from outside the Fire operation • Mobile LTE networks • Courier	High-bandwidth access to a geographically optimized, resilient network of data depots (prototype network in place)
Moving files (to the IC from) within a disconnected fire operation • Cell on wheels • Mesh radios • Courier	Wireless (802.11 or LTE) access to a self-organizing network of transient/mobile nodes
Standardized data access across frontend clients • EGP (Desktop) • ATAK (Mobile)	Integrating with existing systems to improve edge-access; ie no latency from waiting for backpropagation of data to centralized servers
Offloading aerial data • Aircell • Couriers	Download resiliency in speed and disrupt-tolerance
Backhauling disconnected IC operation record • Mobile LTE / Cell on wheels • Courier	Intermittent updates where possible; less redundancy when connectivity is (re)established

Project Goal & Impact

Project Goal:

To deliver rich and informative data with a robust system that supports file transfer and access across disconnected, heterogeneous networks.

Enhance and extend current operational data sharing capabilities for:

- Improved firefighter and public safety
- Better wildland fire predictions
- More informed fire operations (wildfire and prescribed fires)

PSCR Vision:
Public safety services and mission critical systems will be able to function properly in situations of poor network connectivity due to natural interference or infrastructural faults.

Above: The Yarnell Fire began on Jun. 28, 2013, 1.5 miles from Yarnell, AZ from a lightning strike.

U.S. Forest Service photo