Field Deployment Under Urgent and Emergent Conditions
DOT Support for Scaling Team and Basic Alert Management,
the Case of Glenwood Canyon (I-70) February, 2016
Glenwood Canyon – Scope of Issue Local and National

Rockfall work forces alternate routes for I-70...
The Denver Post - 8 hours ago
Rockfall mitigation work using a helicopter will close portions of Interstate 70 in Glenwood Canyon from 9 a.m. to 3:30 p.m. Aug. 10 and Aug.
Glenwood Canyon to close for two days for rockfall mitigation FOX21News.com - 10 hours ago
I-70 in Glenwood Canyon to be closed for most of Wednesday...
Grand Junction Daily Sentinel - 9 hours ago
Canyon closure rescheduled for Aug 10, 11
Local Source - Glenwood Springs Post Independent - 6 hours ago

Wind halts Glenwood Canyon work; I-70 open Thursday
The Denver Post - Jul 28, 2016
High winds in Glenwood Canyon Wednesday forced crews to halt helicopter work on a rockfall mitigation project that was expected to also...
Closure of I-70 through Glenwood Canyon postponed
Colorado Springs Gazette - Jul 26, 2016
I-70 Open Through Glenwood Canyon After Rockfall Mitigation
CBS Local - Jul 27, 2015
CDOT: The average daily traffic for Glenwood Canyon is around 300 vehicles per hour. In the summer season, that number can swell to around 500-600 vehicles per hour.

Detour costs are estimated at 1.3 to 1.6 million dollars a day in commercial losses.
Event Timeline 2016

- 2/16: Rockfall events in the evening take out semi – I-70 closed.
- 2/16: IDSNA contact Ty Ortiz – CDOT Geohazards Program Manager and Sector colleagues.
- 2/17: IDSNA Call and left message offering to assist.
- 2/18: IDSNA receive inquiry from CDOT: “How quickly could the trial warning system be deployed? We would like to look into it, at for the duration of the repairs.”
- 2/20: IDSNA staff meet in Golden office, review instrument configuration and brainstorm deployment needs. (Railroad right of way crucial) – Trailer rigging for lift, welding, cellular mods (networking), extended battery pack, genset and fuel.
- 2/22-24: UPRR site visit, clearing, rail crane order.
- 2/25: IBIS unit deployed and scanning.
2/16-2/23 - Site Geotechnical Assessment/Active Chutes
IBIS-FM ... a modular system for flexible deployments

- Scan time independent from coverage - less than 3 min
- Long scan range (up to 4km / 2.5mi i.e. away from working/blasting areas) and wide coverage
- High spatial resolution and sub-millimetric accuracy
- Limited moving parts and reduced maintenance

State-of-the-art processing and atmospheric correction
No system pause for strong winds

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IBIS-FM Area coverage, spatial resolution, scan time

Typical area coverage:
80° of horizontal aperture and 60° of vertical aperture

Typical spatial resolutions:
• range bin: 2.46’
• cross-range: 14.1’ @ 3,281’

Typical scan time:
• typically 2.5 min for a full resolution image @ 6,562’
IBIS Instrument Configuration and Preparation
IBIS-FM Site Deployment: UPRR Coordination and Support
IBIS-FM Site Deployment: Skids / winch under power line
IBIS-FM ready to scan – acquire DTM
IBIS- FM scanning begin 2/25/2016 each scan < 3 minutes
Data: 3 days 1 “point” : range – 935’ cell size 3.28’
Data: 34 days Area 3 – 62 cells = 804 square feet
Data: 34 days Area 3 – 62 cells = 804 square feet
Reporting: General System Report

IDS NORTH AMERICA
INGEGNERIA DEI SISTEMI

16th Annual Forum
Geohazards Impacting Transportation in Appalachia

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DATE: Monday, February 29th, 2016

SYSTEM STATUS
- Site: Devils Hole Creek
- Equipment: MP 351.19
- Engine Time: 618 Mnt.
- Power: AC line/Battery
- System Time: 77 Hours
- Availability Hours: 77
- Voltage: 27.8
- Battery: 121 S

ERRORS
- TCP Connection

ALERTS
- Power Inverter replaced. Generator placed as third support. AC line reconnected. Batteries added.

COMMENTS
- General activity monitored and all systems monitored as per plan.
- SVS response: AC line connection replaced and system restarted at 11:00 AM successful.
- Glencoe Canyon - IBIS Unit was restarted today at about 11:00 AM. Following the line disruption and surge, ISDNA installed a new power inverter for the system. The generator was placed in reserve, as batteries are sufficient for 8-9 days runtime. ISDNA data is viewed in the Guardian software suite. Below we can see several areas chosen for specific time series or other graphs. Within the Figure below we can see the aggregate displacement for area 4 (approx. 302 SQ ft.) that is comprised of 55 DMX cells.
- Hazard areas and alerts can be user-configured with selectable displacement indicators or velocity rates. These alerts are visible, logged, and can be shared via SMS messaging or by e-mail. ISDNA will support CDOT in the selection of generalized notes, and the associated amounts that can be set for specific "level" of alert. Alerts should be specifically linked to a event or emergency action plan.

Event Notes or Data

<table>
<thead>
<tr>
<th>DATE</th>
<th>EVENT</th>
<th>NOTE</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/24/2016</td>
<td>SVS responding well.</td>
<td>DTM to be available next week.</td>
<td>Initial data acquisition began, weather ok - some snowfall - generally clear, remote communication good, then intermittent data downloaded on local PC.</td>
</tr>
<tr>
<td>2/27/2016</td>
<td>SVS responding well.</td>
<td>DTM flight scheduled. Man C in effect.</td>
<td>System tracking data was lost and data was reacquired present. Power surge on Cessna engine resulted in failed inverter, to be replaced. Line power distribution in process.</td>
</tr>
<tr>
<td>2/28/2016</td>
<td>SVS scanning powered down at 6:14 due to low battery alert.</td>
<td>DTM team to visit site on 3/2/2016.</td>
<td>ISDNA to add high-capacity cells and move to main AC line after surge event. Generator restart was sufficient after surge. Customer Care team will reset limits, alerts, and add 23 days of battery access.</td>
</tr>
<tr>
<td>2/29/2016</td>
<td>SVS scanning restart began at 11:00 PM.</td>
<td>DTM team to visit site on 3/2/2016.</td>
<td>General system response is good, IBIS unit not affected by power outages. DTM team suggested alert scenarios to be shared with CDOT team.</td>
</tr>
</tbody>
</table>

General Notes and Disclaimer:
1. It is agreed that the Supplier (ISDNA) is liable to the Customer, or any person or associate of the Customer, for any mistake or error in furnish or for loss or damage or delay in delivery, technical, on site, general services, and the User shall be liable for the effect of such errors or delays.
2. It is further understood and agreed that the Supplier (ISDNA) is liable to the Customer, or any person or associate of the Customer, for any mistake or error in furnish or for loss or damage or delay in delivery, technical, on site, general services, and the User shall be liable for the effect of such errors or delays.
3. ISDNA shall not be held liable for any loss or damage or delay in delivery, technical, on site, general services, and the User shall be liable for the effect of such errors or delays.
HAZARD MAPS Aggressive Alerts – Level 1 and 2 in inches per hour
Weekly Reporting: Data Quality and Highlights

1. Summary

The IBS-M unit performed as normal during this time period. The IBS unit is running on line power provided by Union Pacific Railroad (UPR) and is backed up by four large capacity batteries. During the time period covered by this report, work on the slope was completed (on approximately the 10th of March), so this report covers a period where personnel were working on the slope and when they were not.

Movement trends during the week tended to be linear, with very few large scale acceleration trends exhibited. Some small acceleration trends were present that lasted approximately 24 hours. Areas described in this report were selected by IDS personnel as they indicated regular and significant displacement during this monitoring period. The areas in this report are shown in the image below (indicated with black arrows). This report will focus on the areas called “Area 4,” “Area 7,” and “Area 8.”

Table 1 below shows some basic statistics of the areas noted in Figure 1 of this report. It should be noted that all displacements in the direction of the radar (i.e., down slope) are shown as negative values.

2.2 Area 7 Graphs

![Graph Image](image-url)

**Displacement Time Series**

**Velocity Time Series (1 hr average):**
Glenwood Canyon Event - Deployment Highlights

- Days Scanning = 34
- Hours scanning available = 802
- Number of Scans = appx 16,040
- System Availability % = 98.3 percent
- Cost per hour < $40.00