A NOVEL SATELLITE ARCHITECTURE FOR DETECTION AND MONITORING OF EXTREME EVENTS IN REAL-TIME

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EXTREME EVENTS REQUIRE RAPID VERY LOW LATENCY EO PRODUCTS

In many EO scenarios, the EO products are only useful if available in a very short time period

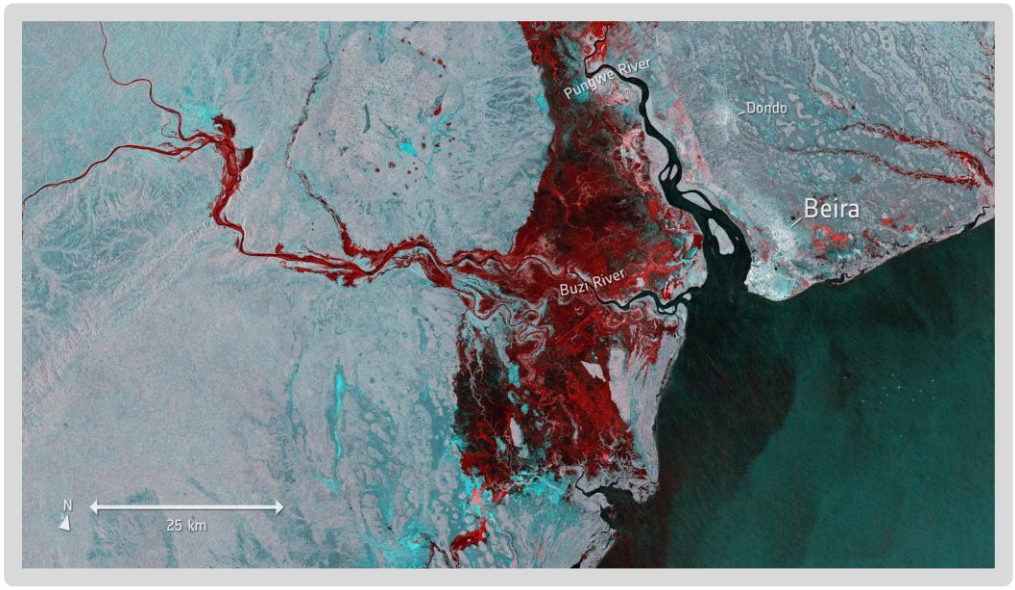
Scenarios needing very low latency products include:

- **DISASTER MANAGEMENT AND EMERGENCY RESPONSE** (e.g. Floods, Fires, Earthquakes, Oil slicks, ..)
- **FORECASTING** (e.g. extreme weather nowcasting)
- **MONITORING AND SECURITY** (e.g. maritime smuggling, illegal fishing, illegal immigration, …)

2019 & 2020, Australian Fires

Credit: ESA/Sentinel -2 , Copernicus EMS – CC BY-SA IGO 3.0

2019, Cyclone Idai (Mozambique)



Credit: ESA/Sentinel – CC BY-SA IGO 3.0

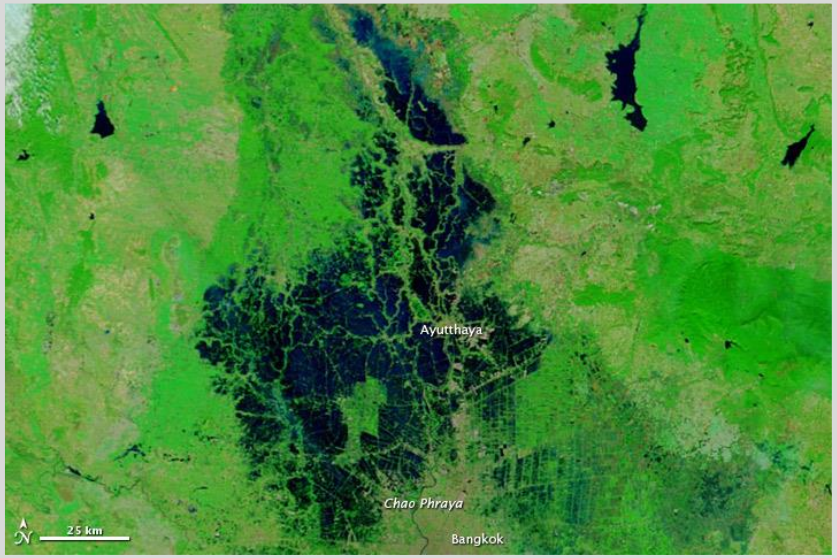
EXTREME EVENTS REQUIRE RAPID VERY LOW LATENCY EO PRODUCTS

Current latencies of civil emergency products are **BETWEEN 30 MINUTES AND SEVERAL HOURS**

Improved systems to support rapid detection and distribution of information are required

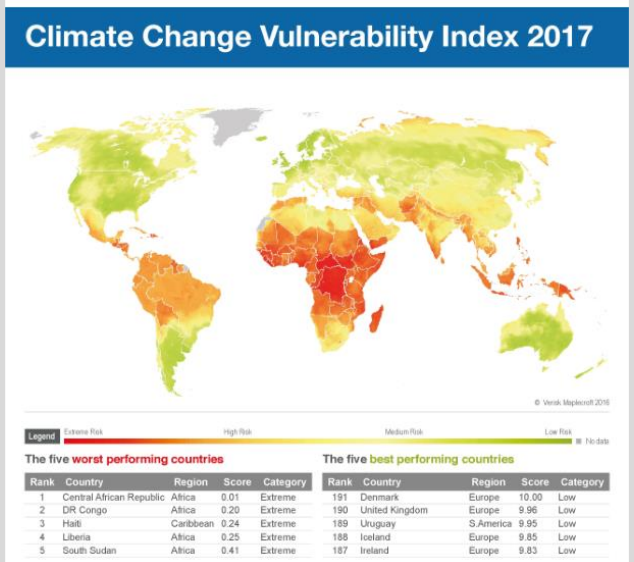
- **MOTIVATED BY UN SDGS, UN-SPIDER, WMO, ETC**
- **MOTIVATED BY CURRENT AND UPCOMING CHALLENGES TO MITIGATE THE EFFECTS OF CLIMATE CHANGE**

Timely Earth Observation Products Can **SAVE LIVES & PROPERTY**



2011 Floods, (Ayutthata, Thailand) "**NASA Space Data Can Cut Disaster Response Times, Costs**", NASA, 2019

Credits: LANCE/EOSDIS MODIS Rapid Response Team, NASA's Goddard Space Flight Center



MISSION ARCHITECTURES FOR RAPID VERY LOW LATENCY PRODUCTS

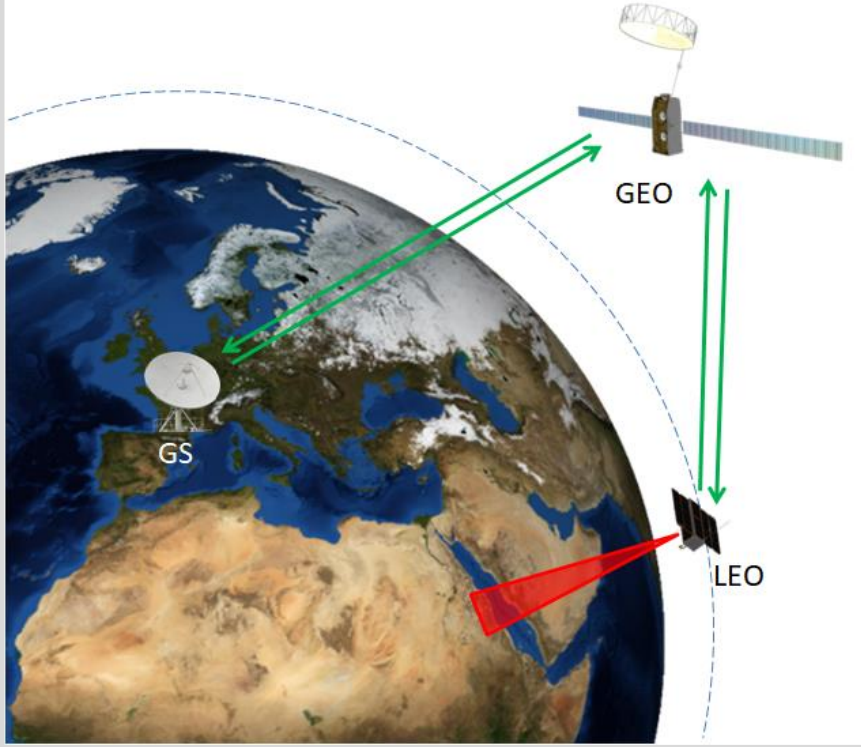
CAN WE PROVIDE CONTINUOUS REAL-TIME MONITORING?

Existing EO architectures are LIMITED. Three basic problems arise:

- TIME FOR SATELLITE TASKING (UPLINK)
- TIME TO ARRIVE AT THE GROUND STATION FOR DOWNLINK
- TIME FOR DATA DOWNLOAD

Solve all these limitations using new architectures based on **CONSTELLATIONS** of small-sats with **ON-BOARD PROCESSING** and **GLOBAL COMMS LINKS**, offering a promising **LOW COST** solution

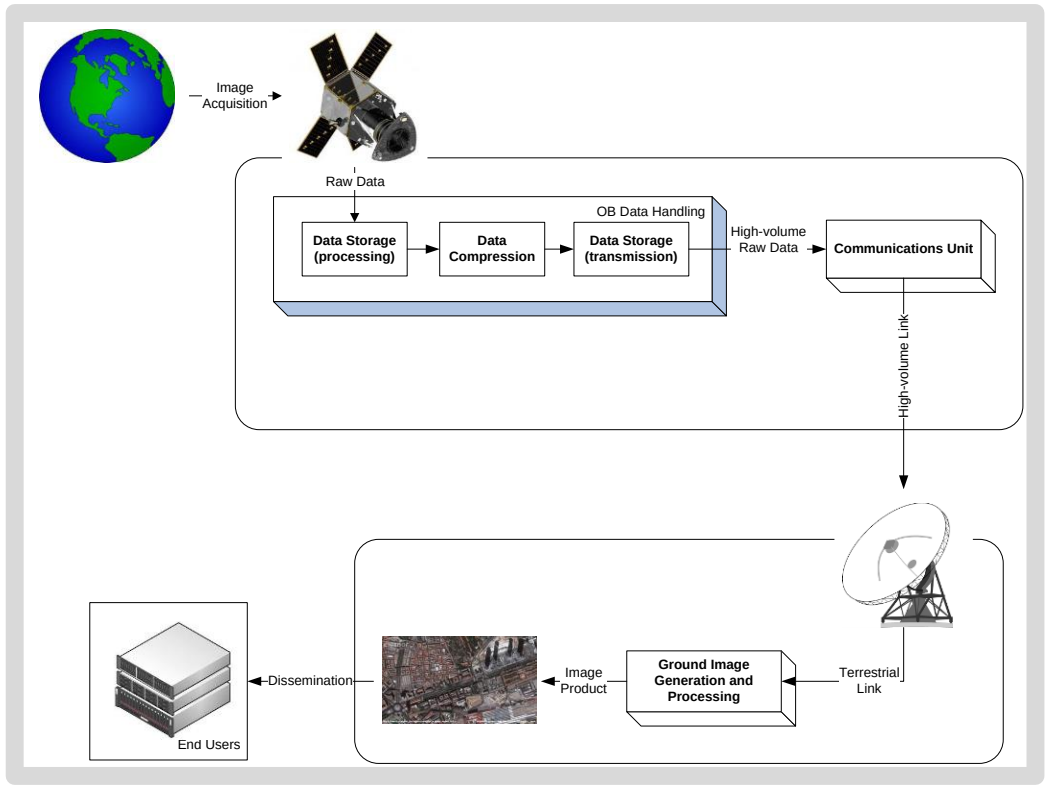
- ALLOW FOR CONTINUOUS DETECTION AND MONITORING OF EXTREME EVENTS IN REAL-TIME
- DEPLOYED GLOBALLY OR REGIONALLY



New EO architectures **EXPLOITING ON-BOARD PROCESSING** & **GLOBAL COMMUNICATION LINKS**

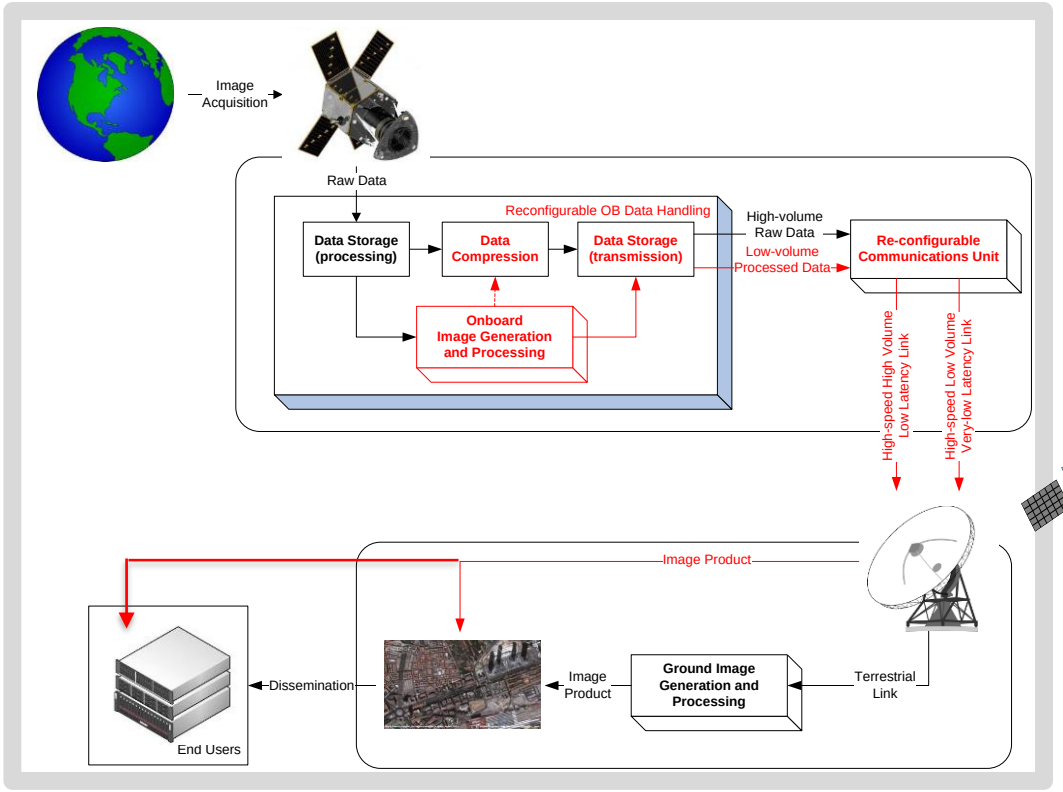
INNOVATION FOR RAPID VERY LOW LATENCY EO PRODUCTS PROVISION

CLASSICAL EO DATA CHAIN
> 30 MINUTES LATENCY



INNOVATION

"NEW" EO DATA CHAIN
CONTINUOUS AND REAL-TIME



SOLUTION FOR RAPID RESPONSE AND VERY LOW LATENCY EO PRODUCTS

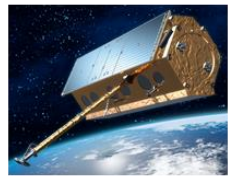
GOAL: address the need for very low latency EO data products

IDEA: focus on the EO product and what is needed with very low latency

PROOF OF CONCEPT

- Develop a new approach exploiting the flight segment processing capabilities
- Move EO data processing elements from the ground segment to the satellite
- Using 2 real VHR Optical and SAR instruments
  - **TerraSAR-X (SAR)** VHR satellite (1)
  - **DEIMOS-2 (OPT)** VHR satellite (2)
- Also for **MSG SEVIRI** (Multi-spectral) (3)

(1)



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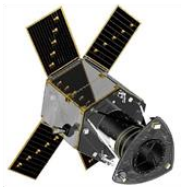

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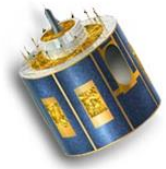


LATENCY GOAL: < 1 MINUTE

EO-ALERT PROJECT RESULTS

EMSA VDS PRODUCT

- Ship Detection, Classification, Positioning
- Tested On Terrasar-x And DEIMOS-2 VHR Satellite Data
- Current Results For SAR And Optical Close To 1 Minute Goal

SAR (TERRASAR-X)

- ~2.5 minutes ⚠

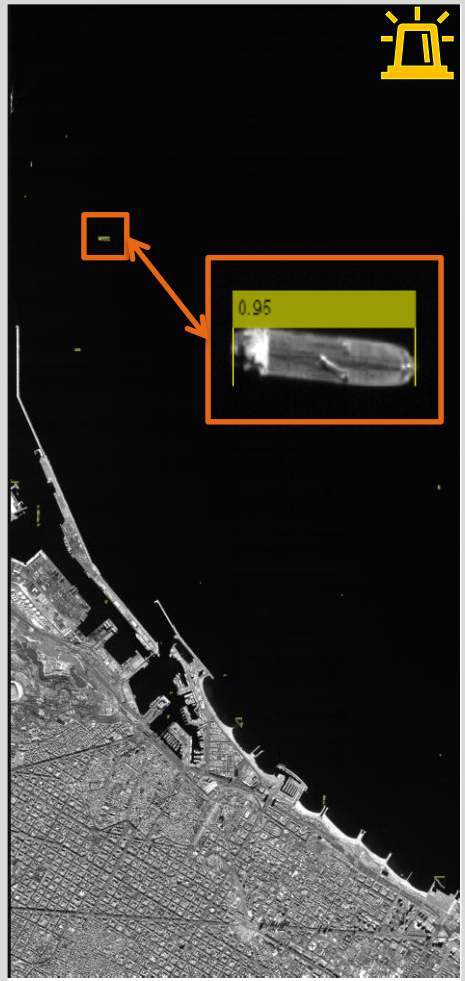
OPTICAL (DEIMOS-2)

- ~2.0 minutes ⚠

VHR OPTICAL
100 km² image
~ 1m resolution image

DMS-2 Optical Payload	
Function	*Latency (seconds)*
OB Processing	67
OB DH	13
Comms	35
Total	~115

EMSA VDS Product



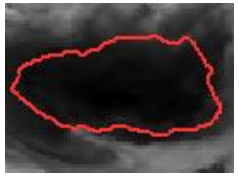
EO-ALERT PROJECT RESULTS

Example of **EXTEME WEATHER NOWCASTING PRODUCTS**

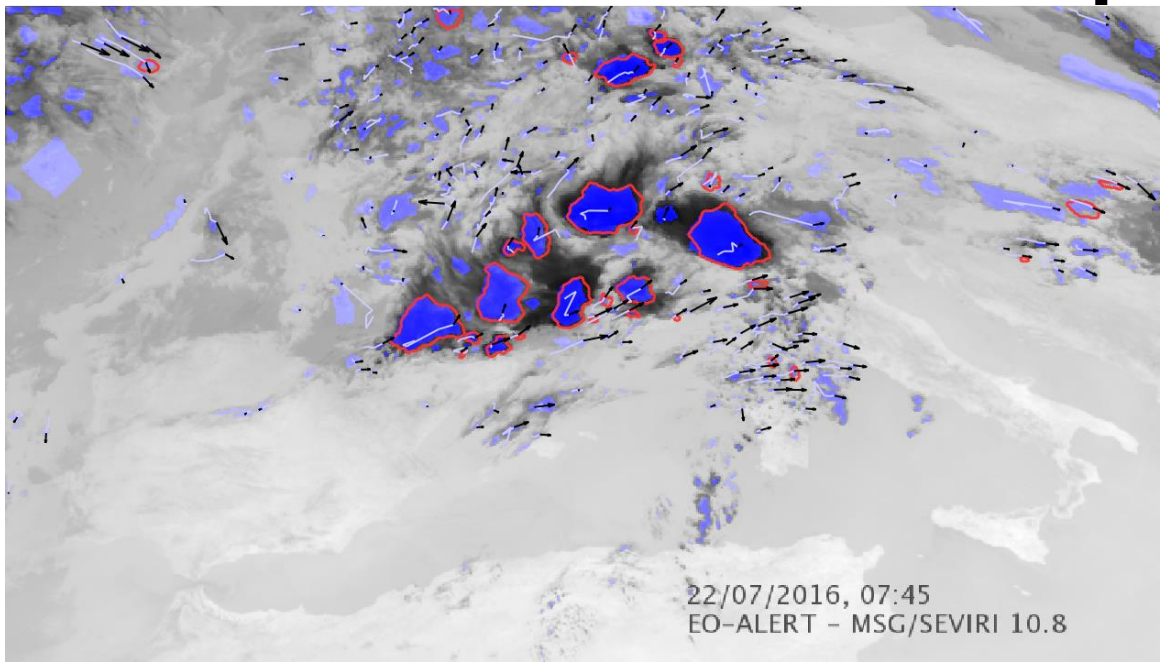
- Similar to EUMETSAT Rapidly Developing Thunderstorm (RDT) Product
- Detect and track convective storms
- Three step solution

Identification of convective cells → Track and extract features → Classify and generate the alert

STORM ALERT



- LAT
- LON
- Extension
- Cooling Rate
- Min Temperature
- Max Temperature

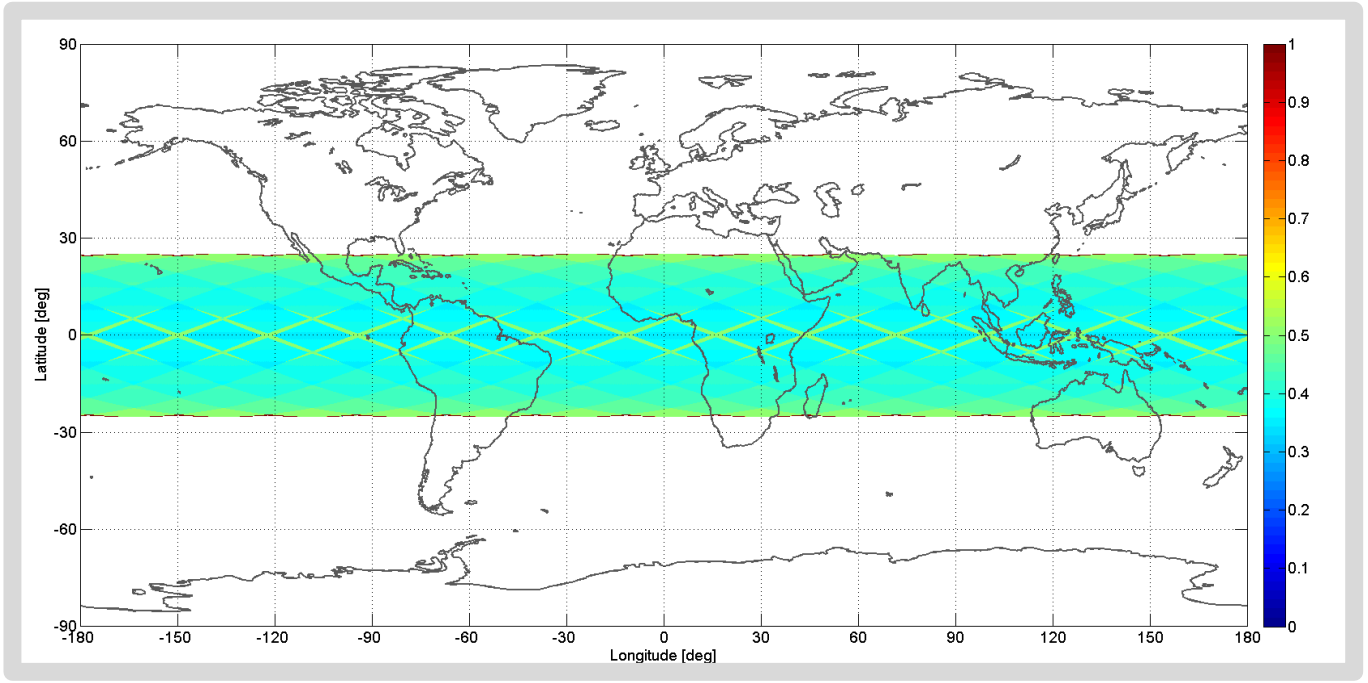


PROVIDE WORLDWIDE RESPONSIVE, REAL-TIME EO PRODUCTS FOR EXTREME EVENTS MONITORING

Example Equatorial Service

EQUATORIAL **METEOROLOGICAL** AND **CLIMATE** CONSTELLATION

24 SATELLITE CONSTELLATION COVERING ALL TROPICAL REGIONS FOR CONTINUOUS DETECTION, MONITORING AND TRACKING OF EXTREME EVENTS



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