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# LANDSLIDE EARLY WARNING ALERTS VIA EXTENDED DATEX II

# Overview



## □ The Landslide Early Warning Project

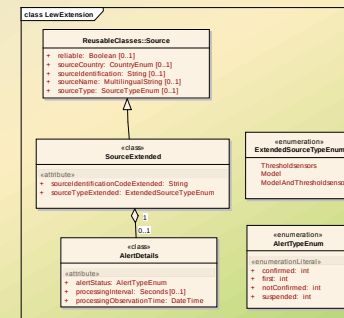
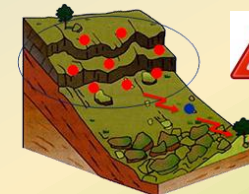
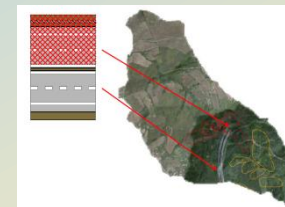
- Monitoring Network and Landslide Alert Generation
- TCC / TMC Operational Context
- Emergency Management requirements

## □ Data Exchange Requirements

- Alert information Exchange and Validation
- Exchange Requirements
- System Monitoring Requirements

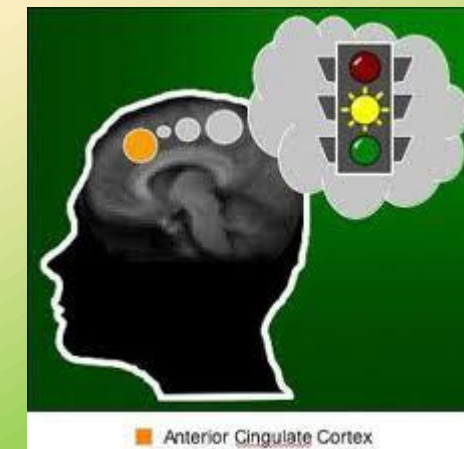
## □ Implementation Detail

- Situation Publication Extension
- Reliability by Exchange Method Combination

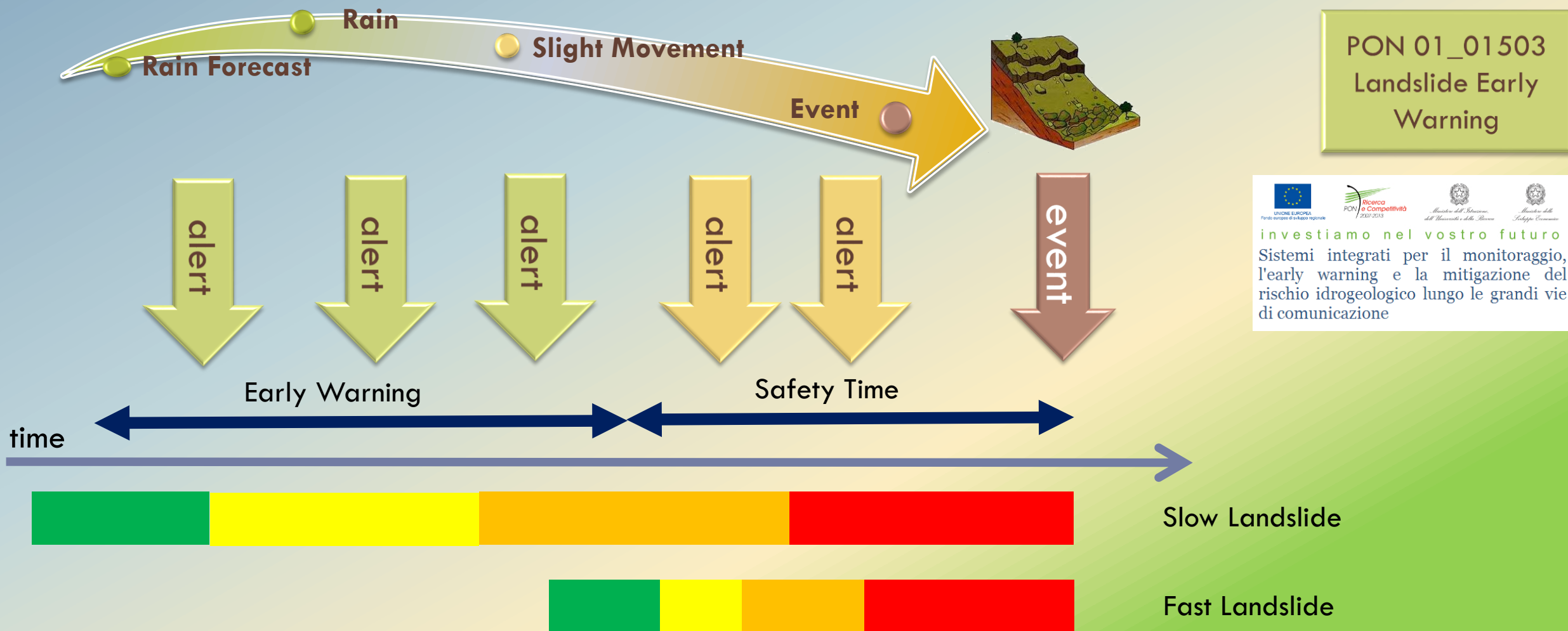


# The Landslide Early Warning Project

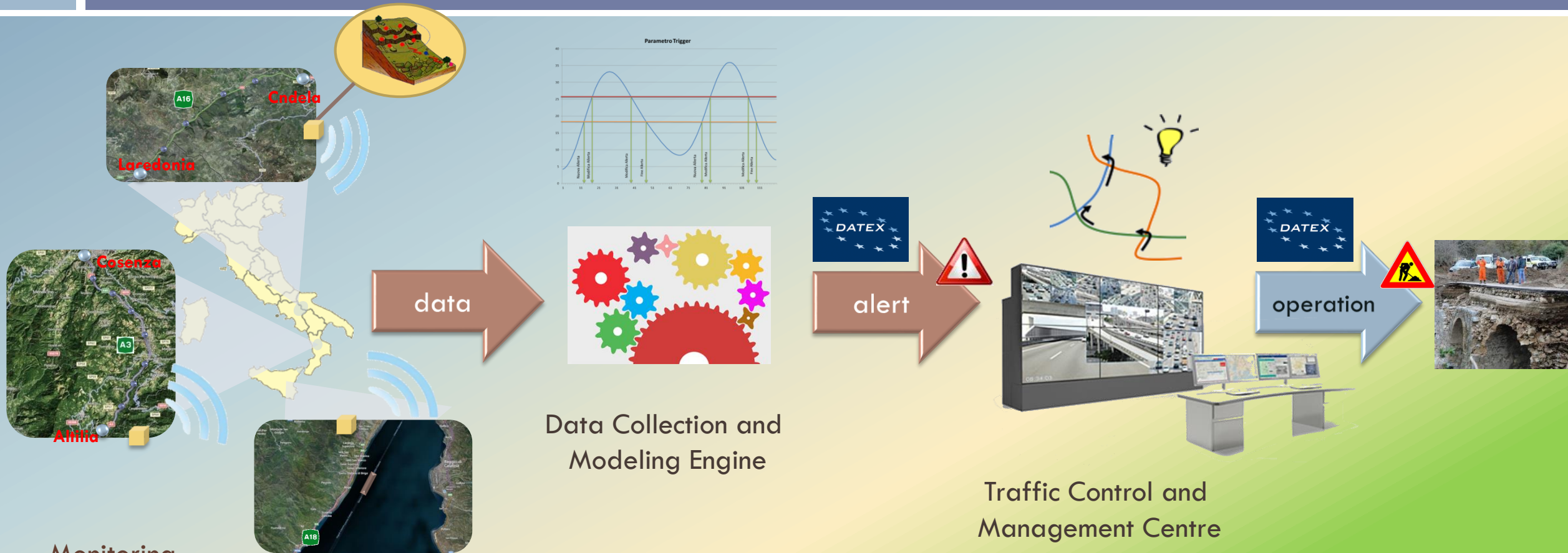
From hydrogeological Monitoring to Landslide Alert Management



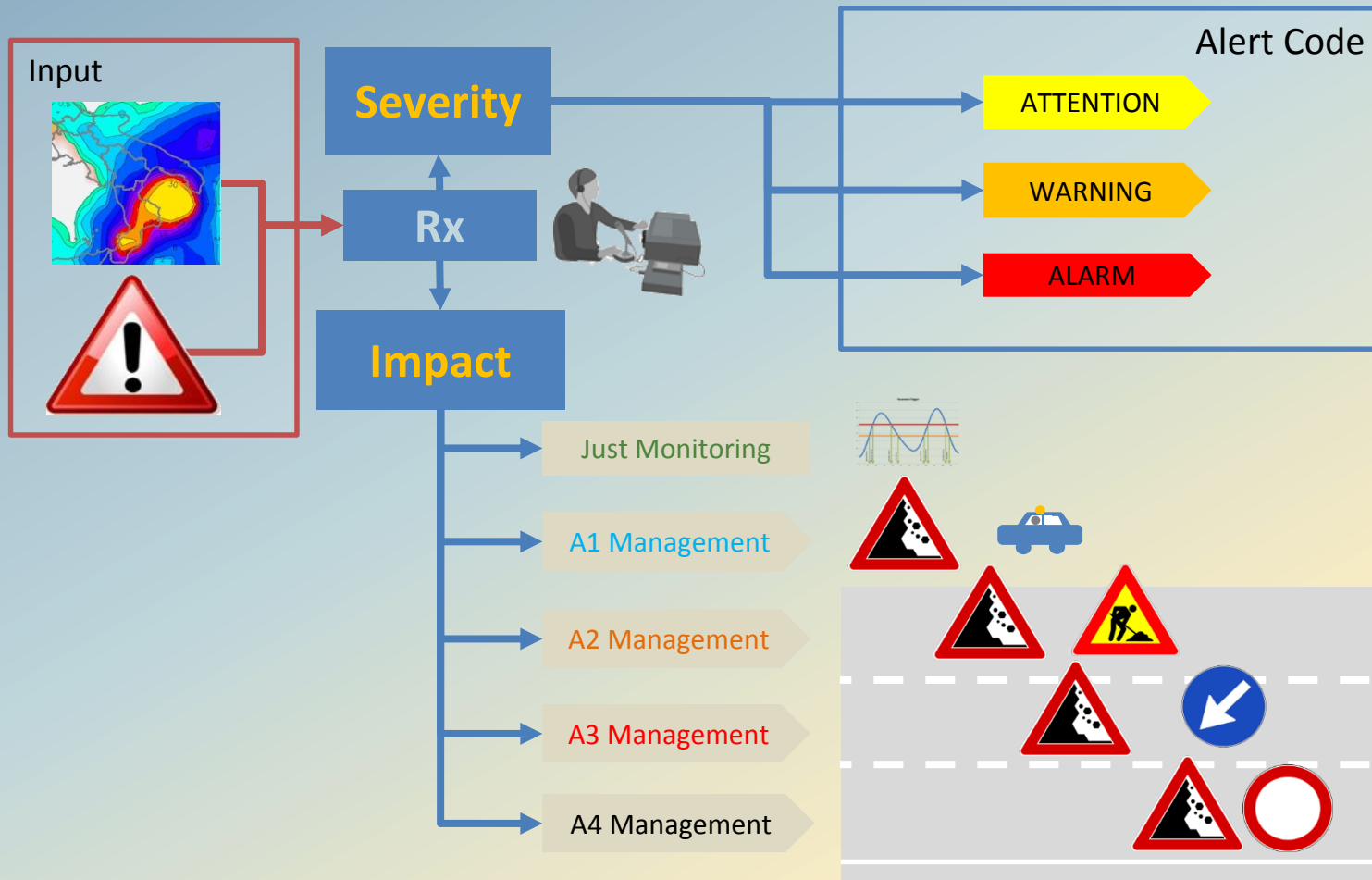
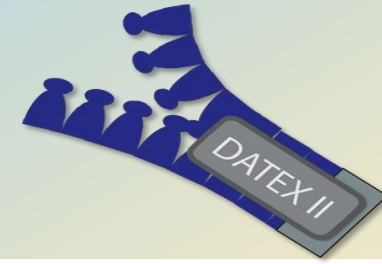
# What is Early Warning ?



# Monitoring Network and Landslide Alert Generation



# TCC / TMC Operational Context

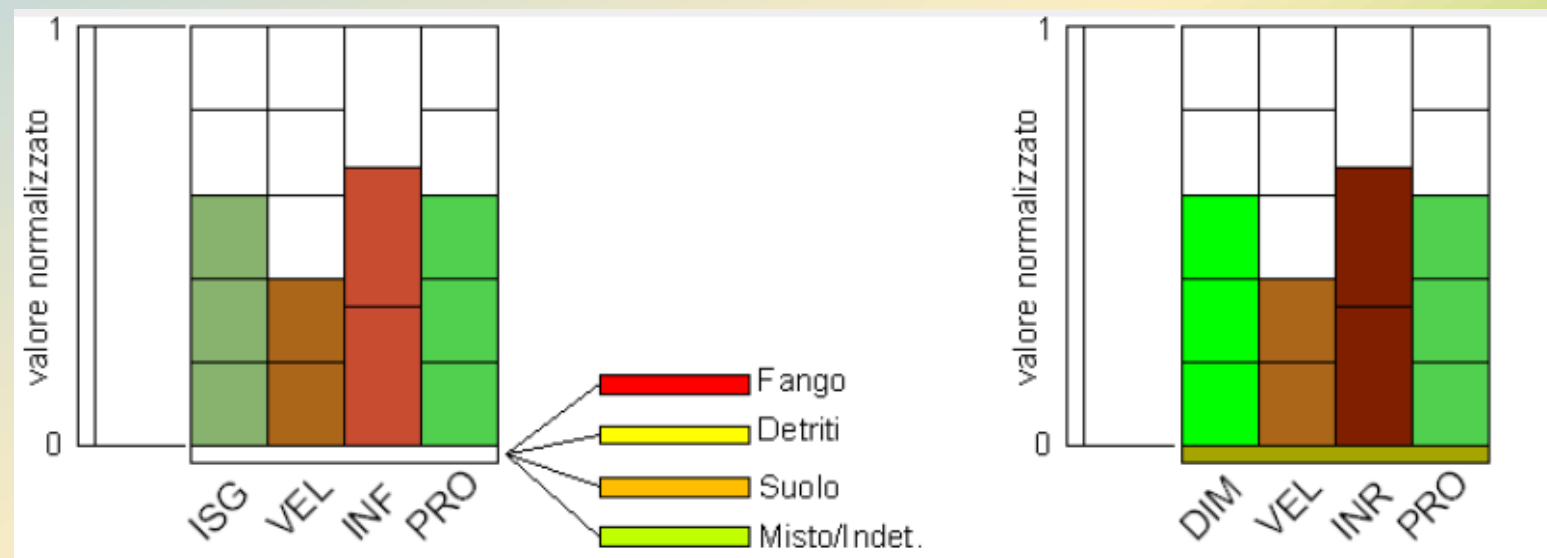


- Probability of Occurrence
- Severity
  - ▣ Communication
    - Area Risk Level
- Impact on roadway
  - ▣ Operation



# Monitoring and Alerting System Requirements

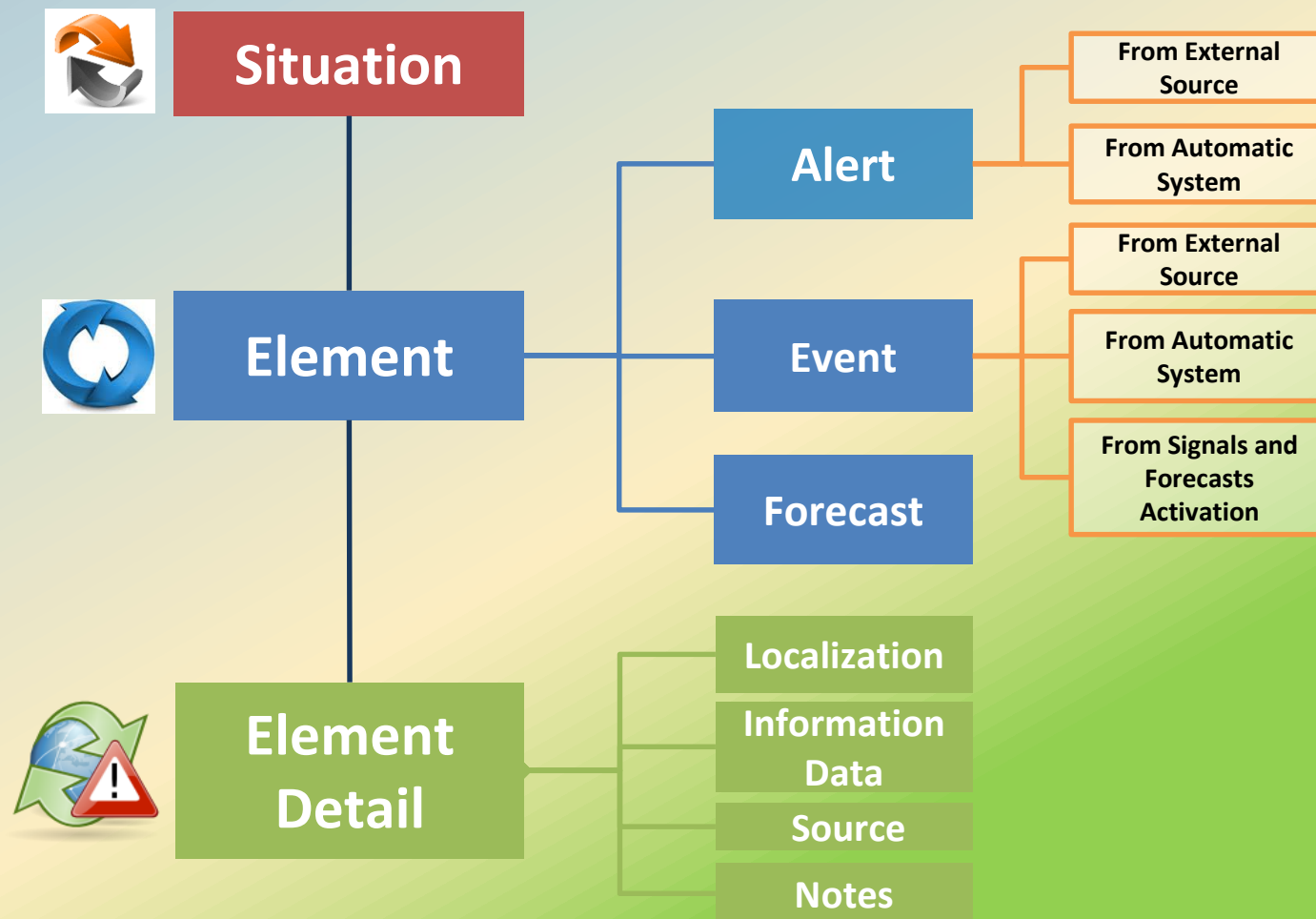
## Landslide Alerts Description and Exchange Requirements



# Alert as pre-Situation Elements

- Situation Publication
- Elaborated Alert
  - ▣ Same data structure
  - ▣ Not Real Time nor Forecast Future Element
- Immediate Risk running
- Operator Validation expected to trigger

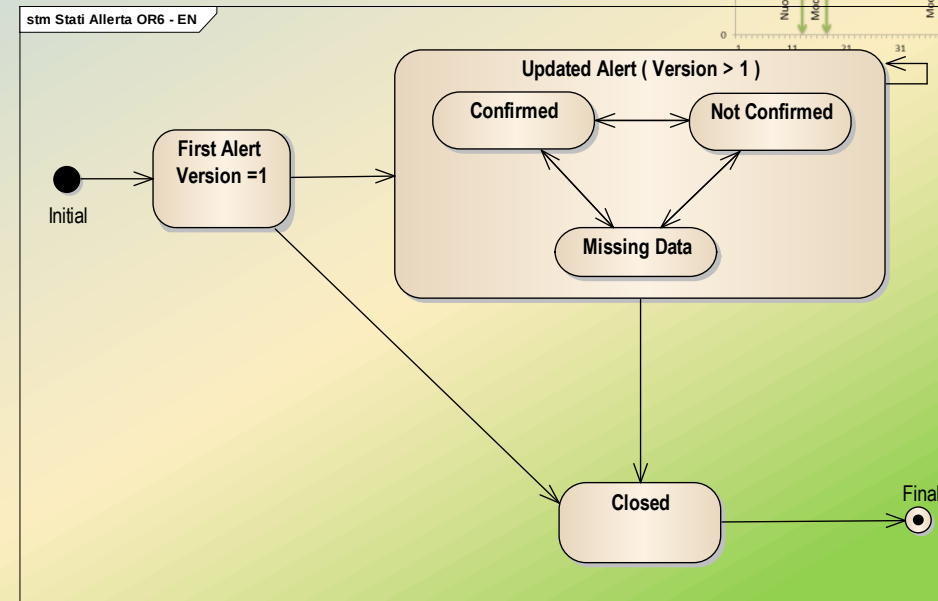
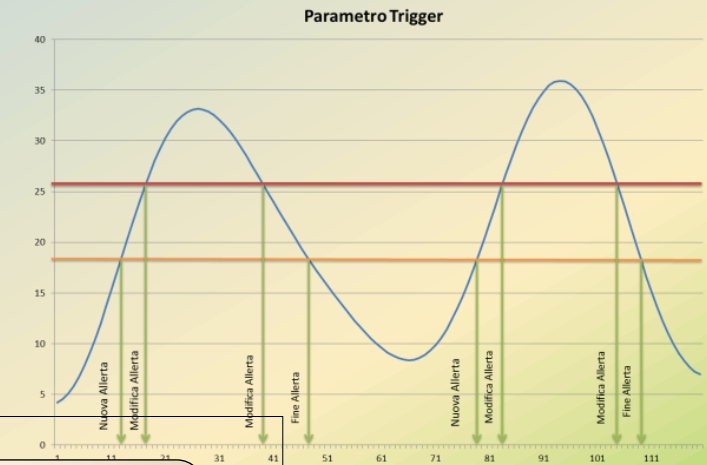
Situation Extension



# Alert Information

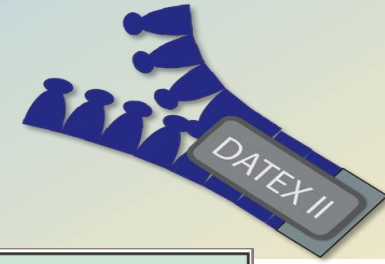


- Validity
  - ▣ Alert not Situation Element
  - ▣ Future Events but..
- Probability of Occurrence
  - ▣ Confidence
- Severity
- Alert Reliability
  - ▣ Hysteresis on Modeling and Threshold



Alert Lyfecycle

# Landslide Information

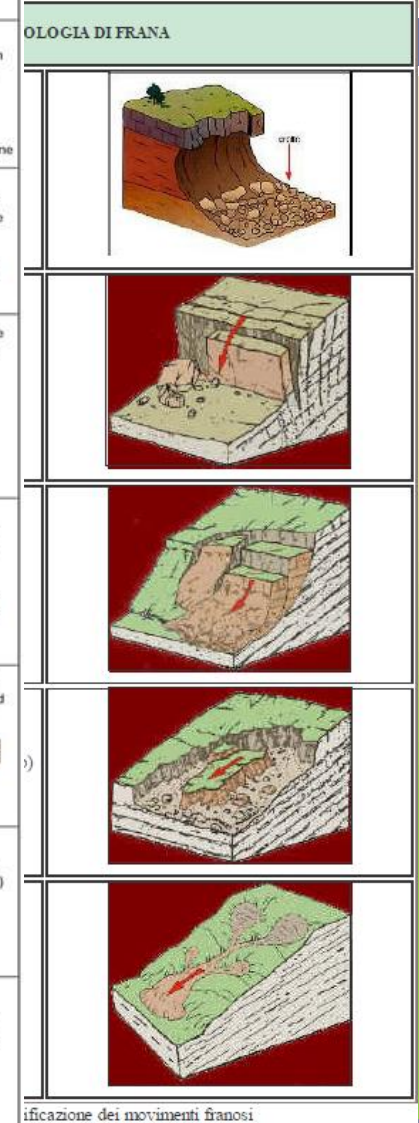


## Physical Landslide Detail

- ▣ Depth
- ▣ Length
- ▣ Area
- ▣ Dynamic
- ▣ Landslide Speed
- ▣ Type of Material
- ▣ Expected Volume

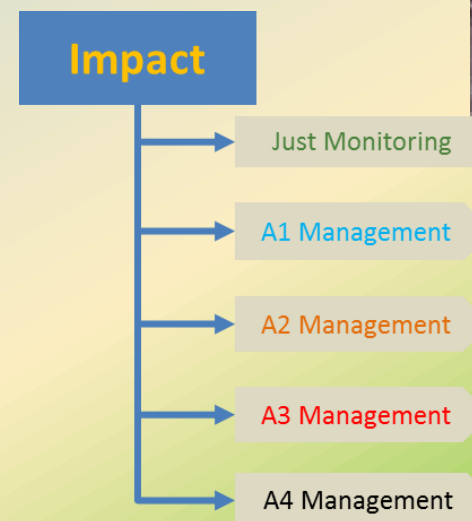
| Material      | ROCK                                                                                                                              | DEBRIS                                                                                                | EARTH                            |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|----------------------------------|
| Movement type |                                                                                                                                   |                                                                                                       |                                  |
| FALLS         | <br>Rock fall                                                                                                                     | <br>Debris fall                                                                                       | <br>Earth fall                   |
| TOPPLES       | <br>Rock topple                                                                                                                   | <br>Debris topple                                                                                     | <br>Earth topple                 |
| SLIDES        | <br>Single rotational slide (slump)                                                                                               | <br>Multiple rotational slide                                                                         | <br>Successive rotational slides |
|               | <br>Rock slide                                                                                                                    | <br>Debris slide                                                                                      | <br>Earth slide                  |
| SPREADS       | <br>Normal sub-horizontal structure<br>Cap rock<br>Clay shale<br>Thinning of beds<br>Plane of décollement<br>Competent substratum |                                                                                                       | <br>Earth spread                 |
| FLOWS         | <br>Solifluction flows (Periglacial debris flows)                                                                                 | <br>Debris flow                                                                                       | <br>Earth flow (mud flow)        |
| COMPLEX       | <br>e.g. Slump-earthflow with rockfall debris                                                                                     | <br>e.g. composite, non-circular part rotational/part translational slide grading to earthflow at toe |                                  |

BGS © NERC



# Landslide Impact on Roadway

- Position
  - Below or Above roadway
- Length
- Material
  - ▣ Volume on Roadway
  - ▣ Landslide, Mudslide, Flooding
  - ▣ Damage, Surface, Infrastructure
- Operational Level on Road



# Exchange Requirements



- Timely
  - ▣ Push On Occurrence
- Reliable
  - ▣ Acknowledge of Data Received
  - ▣ Recovery of Not Exchanged Data
- Awareness of Missing Data
  - ▣ Link Monitoring
    - Session Management
    - Keep Alive



# System Monitoring



- Application Level Keep Alive
  - ▣ Collecting Data Network working
  - ▣ Modeling Engine Correctly working
- Fault
  - ▣ Monitoring Network
  - ▣ Individual Sensor
  - ▣ Modeling and Processing System

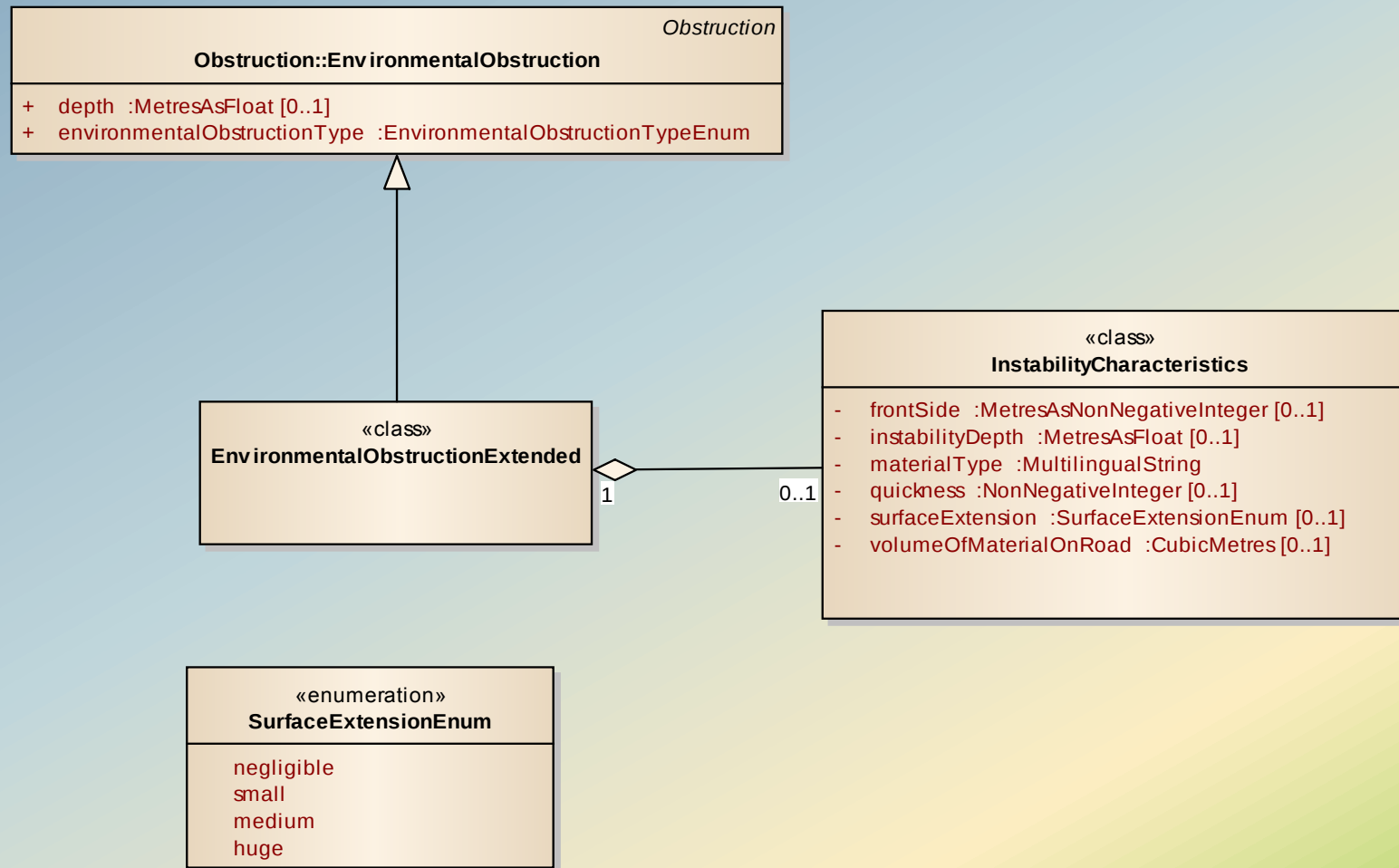


# Implementation Detail

DATEX II coding of Information and Workflow Exchange Management

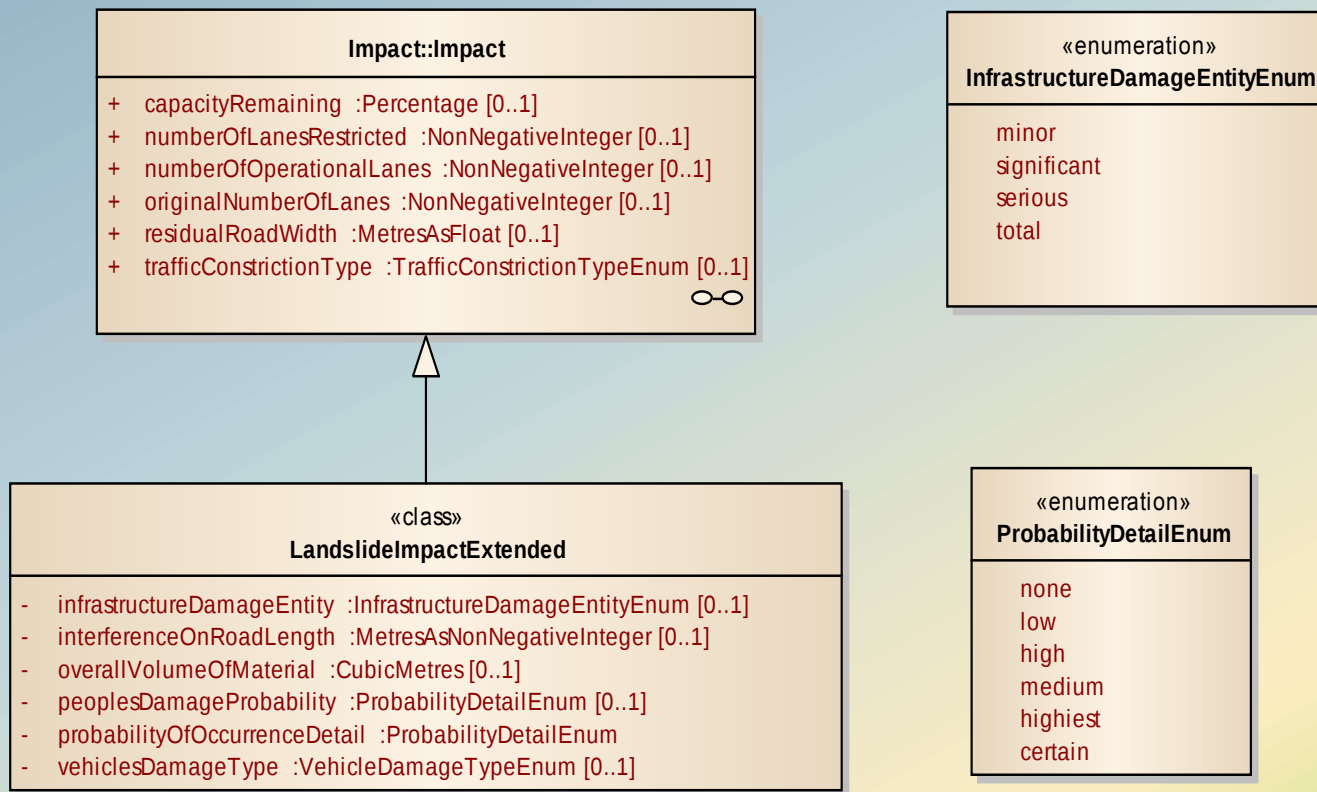


# Landslide Detail



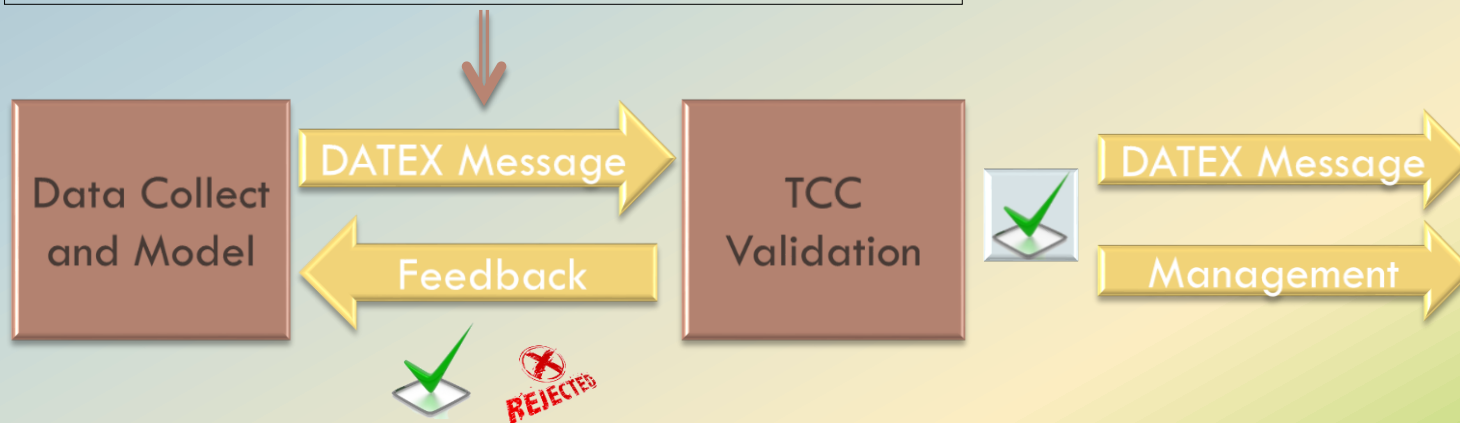
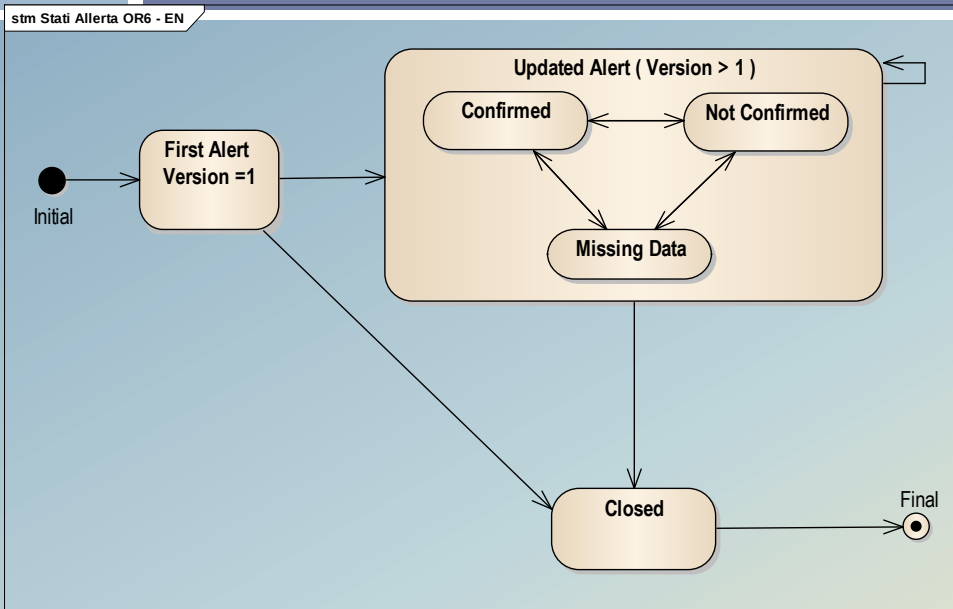
- ☐ Physical Parameters
- ☐ Instability

# Impact Extension



- DATEX II Impact
- Detail to extend  
Landslide Impact

# Alert Lifecycle / Validation



## Validity

### Start Time

- Alert Generation
- Not Event Start only Risk Alert On

### to be Validated by Operator

#### Embedded on Supplier

- Situation Record ( active )

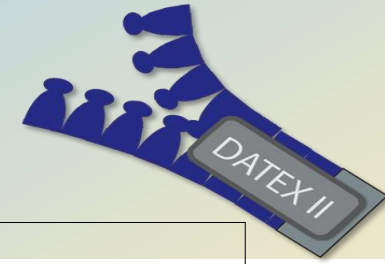
versus

- Alert → Risk of

#### ProbabilityOfOccurrence

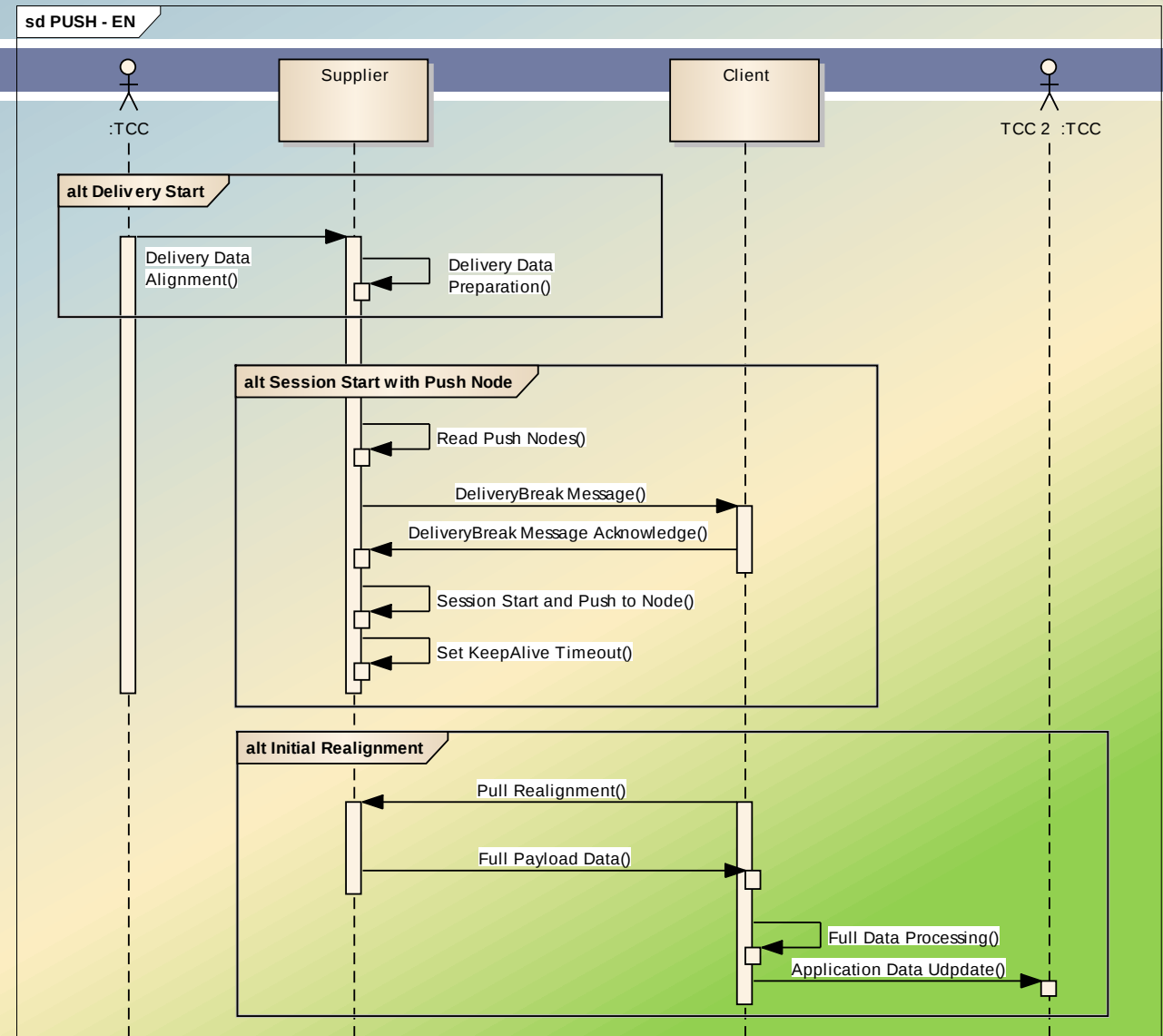
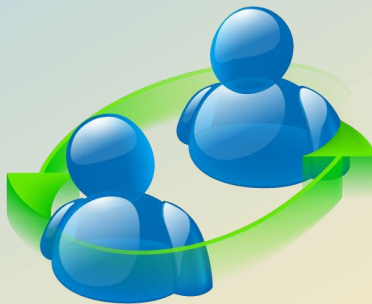
- riskOf,
- probable,
- certain

# Exchange Workflow Sequence Diagram



## Use of DATEX II v2.x methods PULL / PUSH

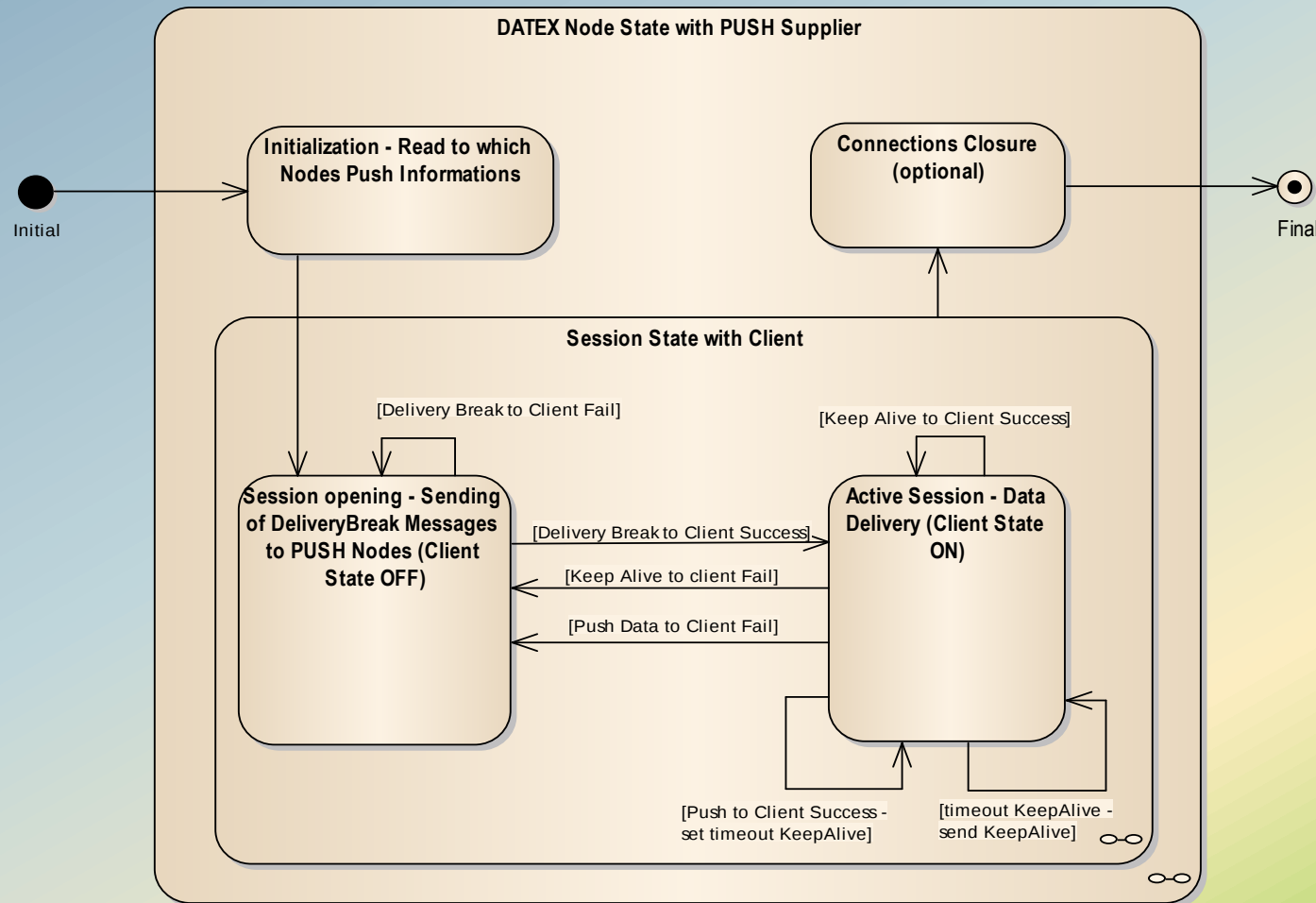
- Combined in an
  - Operating Workflow
  - Peer to Peer Communication
- Delivery Break Message** to inform Supplier is ready to send Data
- Pull Method** to retrieve Current Situation ( active information )



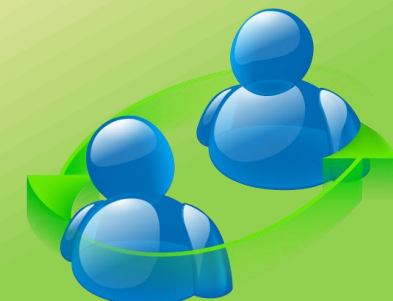
# Exchange State and Workflow - Supplier



stm State Model Supplier PUSH - EN



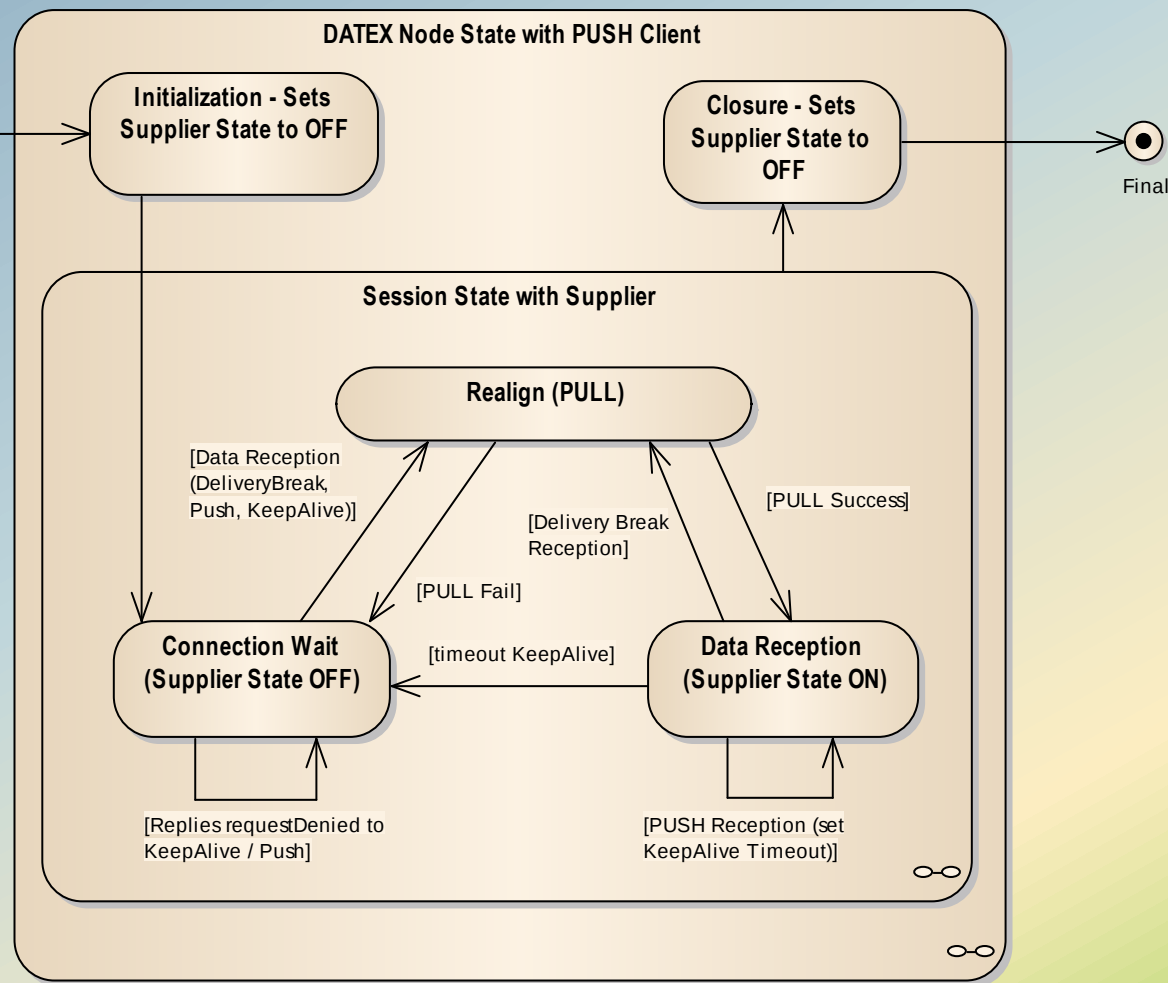
- **Startup:**
  - ▣ Cycle for all nodes which are to delivery
  - ▣ Delivery Break trigger
  - ▣ Pull to Synchronize



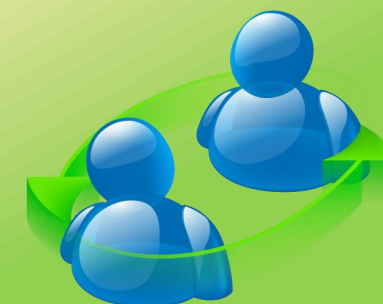


# Exchange State and Workflow - Client

stm State Model Client PUSH - EN



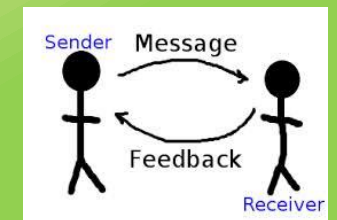
- Pull Method to synchronize after communication failure
- Delivery Break triggered



# Conclusion



- Modeling Alert
  - ▣ Pre Situational Elements same as Road Information Managed in DATEX
- Impact on Management
  - ▣ Impact Description
  - ▣ Time to implement Measure for Safety
- Awareness and Reliability
  - ▣ Monitoring Network and System Status
  - ▣ Data Exchange Full Reliability
    - DATEX II compliant methods





Thanks for your Attention ... Beware 😊

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