INSPIRE Land Cover Data Specifications to model fire access time in Europe: the experience of the eENVplus project

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Summary

- The problem targeted
- FCM (Fuel Classification Maps) for Forest Fire Management
- The ArcFUEL methodology
- An INSPIRE implementation for FCM
- The eENVplus operational scenario

The problem targeted

- Forest Fire (FF) Management requires knowledge of Fuel Classification Maps (FCMs) that are poorly available in Mediterranean countries since they are produced only at local or regional scale, without any regular updates and/or using standardized methodologies.
- Therefore available FCMs cannot support the systematic use of FF modeling at operational levels (prevention, suppression planning) of FF management.

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FCMs for FF Management

- Forest vegetation is considered as a "fuel" and its structure and status govern the dynamics of a fire.
- This is the reason why Fuel Models and their spatial patterns (i.e. FCMs) are significant for FF Management Actions during all four phases of the FF lifecycle:
  - 1 (Awareness phase - prior to the fire)
  - 2 (Emergency phase - during the fire)
  - 3 (Impacts phase - after the fire)
  - 4 (Dissemination phase - lesson learnt).

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The ArcFUEL methodology

- The eENVplus pilot on Forest Fires is based on the operational use of FAT (Fire Access Time), produced using the ArcFUEL methodology
- It consists of cascaded steps based on the use of multi-temporal LANDSAT Thematic Mapper (TM) images for the distinction of fuel classes with different seasonal characteristics and further refinement based on ancillary data, such us burned areas, and canopy cover density data derived from satellite observations.

INSPIRE Land Cover Data Specification

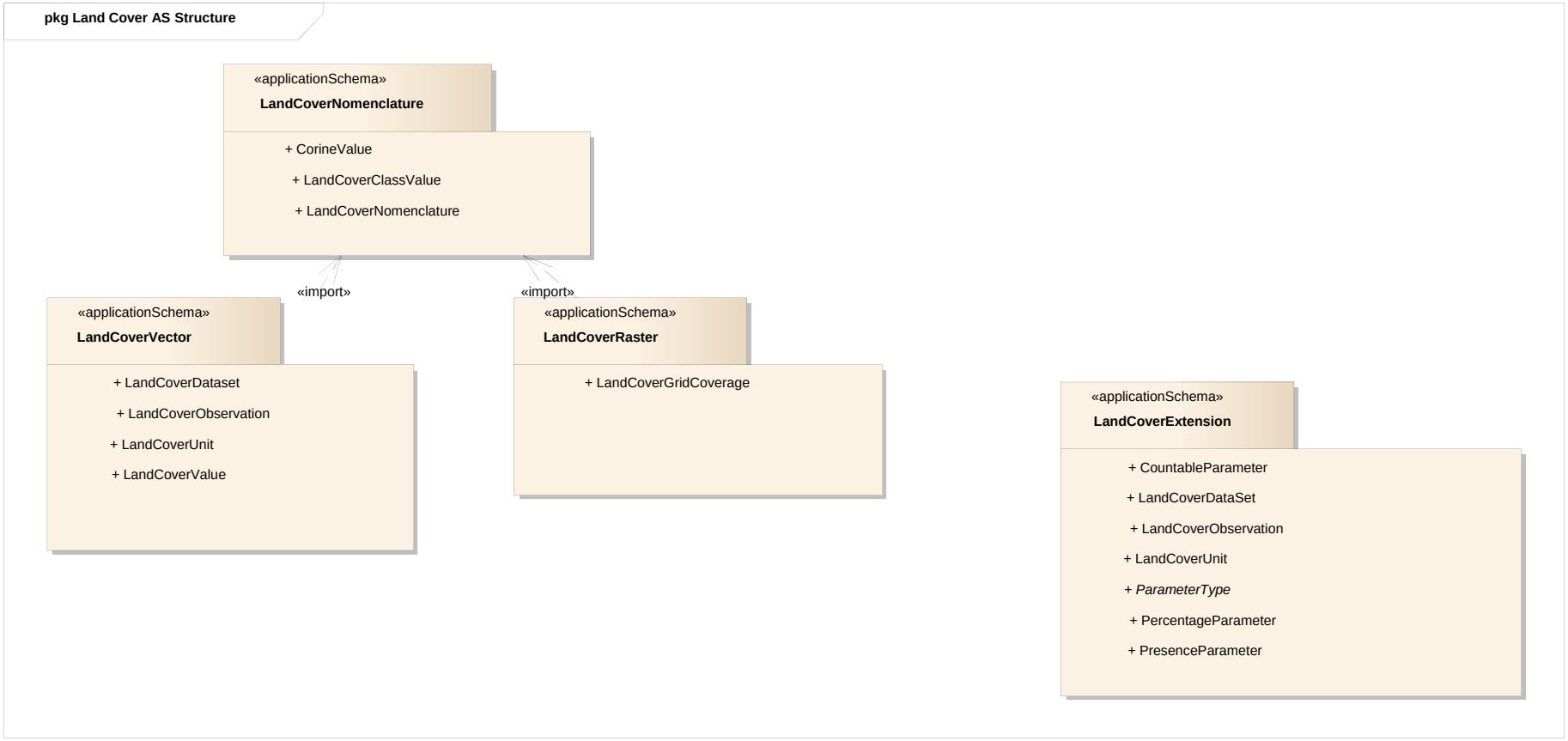
- The Land Cover (LC) data theme has been selected as the most applicable and the relevant DS has been deeply analysed.
- The LC data specification does not prescribe or recommend any particular land cover nomenclature for use in INSPIRE. The approach taken by LC DS is instead to allow many different land cover nomenclatures to coexist in the context of INSPIRE.

INSPIRE Land Cover Data Specification

- The LC DS defines the following application schemas:
  - LandCoverNomenclature application schema;
  - LandCoverVector application schema;
  - LandCoverRaster application schema.

In addition, a LandCoverExtension application schema is defined in order to support requirements from specific use cases and/or may be used to provide additional information.

INSPIRE Land Cover Data Specification



LC UML Packages

INSPIRE Land Cover Data Specification

LC data shall be modeled trough one of the two core applications schemas:

- LandCoverVector defines a vector representation (i.e. points or surfaces) to support Land Cover data.
- LandCoverRaster defines a raster representation to support Land Cover data.

The two schemas differ only for technical reasons, related to implementation aspects:

- only one classification code is allowed per raster cell for the raster representation (multiple codes are allowed in the vector representation in order to follow LC changes).
- no mosaic description allowed for the raster representation.

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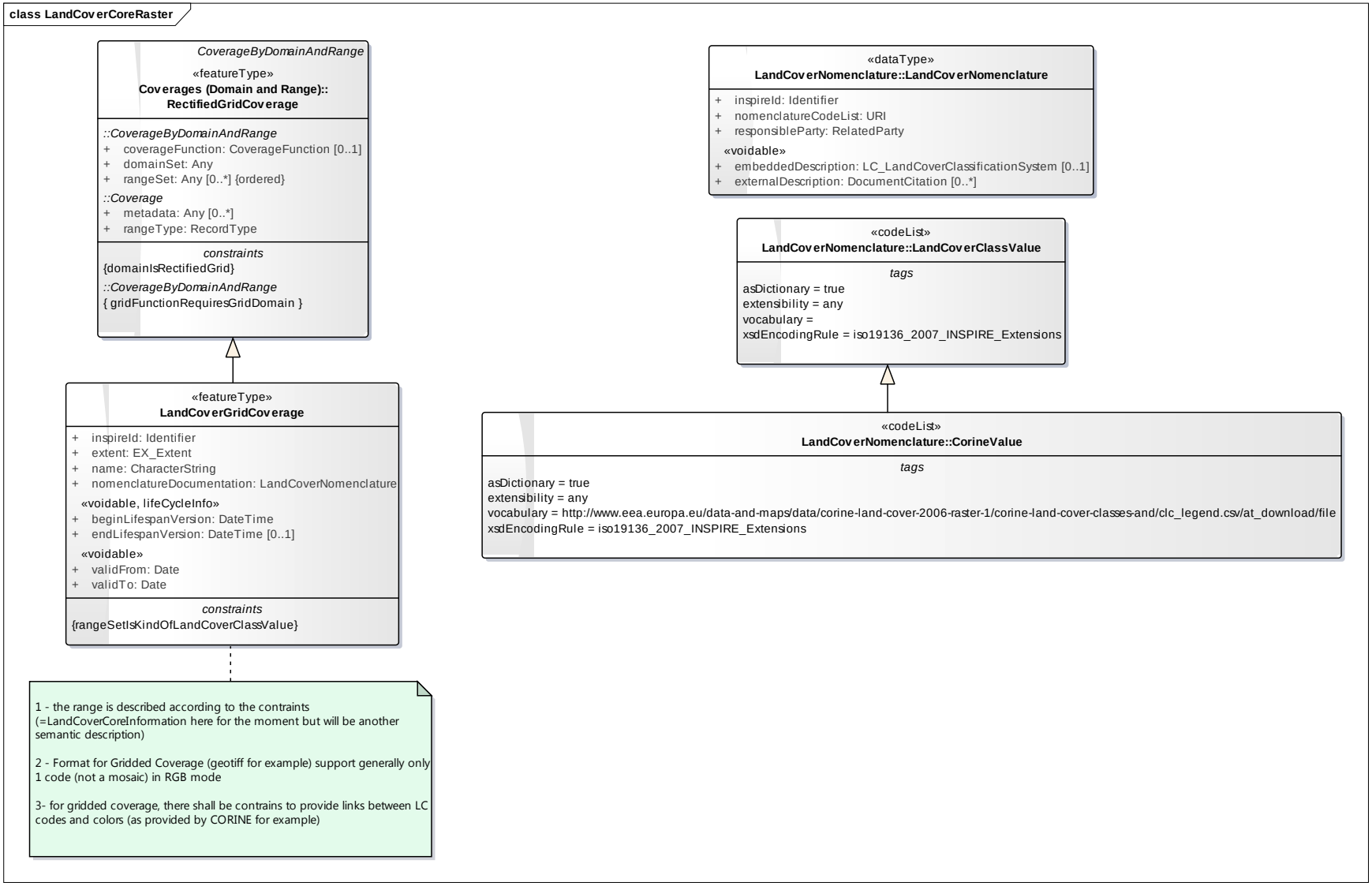
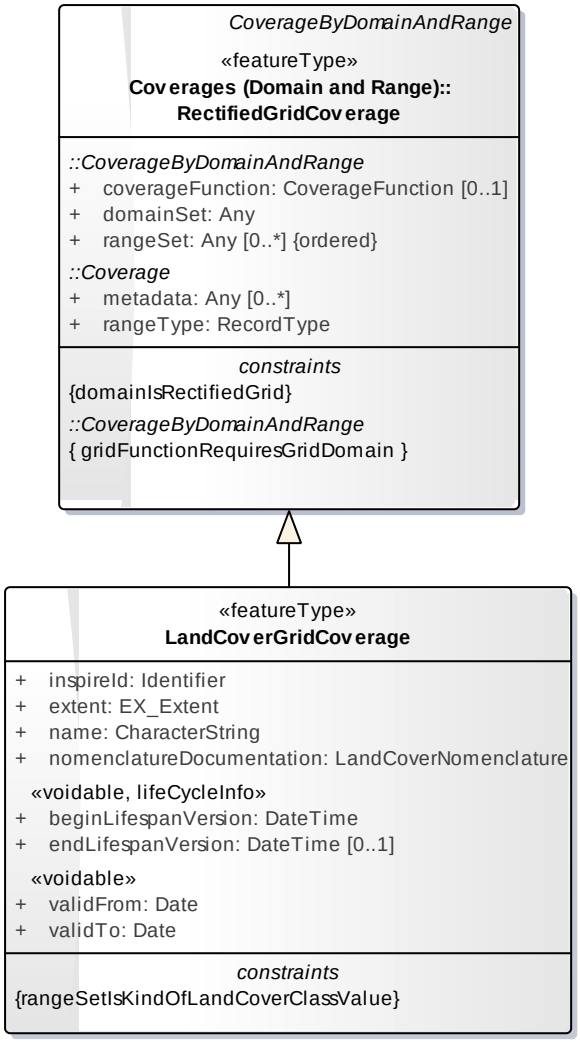
An INSPIRE implementation for FCM

- Following the selection of the LandCoverRaster application schema, the use of the external file option for the encoding of the FCM values has been investigated.
- In order to physically implement this option, the indications contained in the Annex J ('Encoding rules for TIFF and JPEG 2000 file formats') of the "*D2.8.II.2 Data Specification on Land Cover – Technical Guidelines*" and in the Annex C ('Resource identifiers') and Annex D ('Encoding of file-based data') of "*D2.7: Guidelines for the encoding of spatial data, Version 3.3*" have been followed.

LandCoverRaster Class diagram



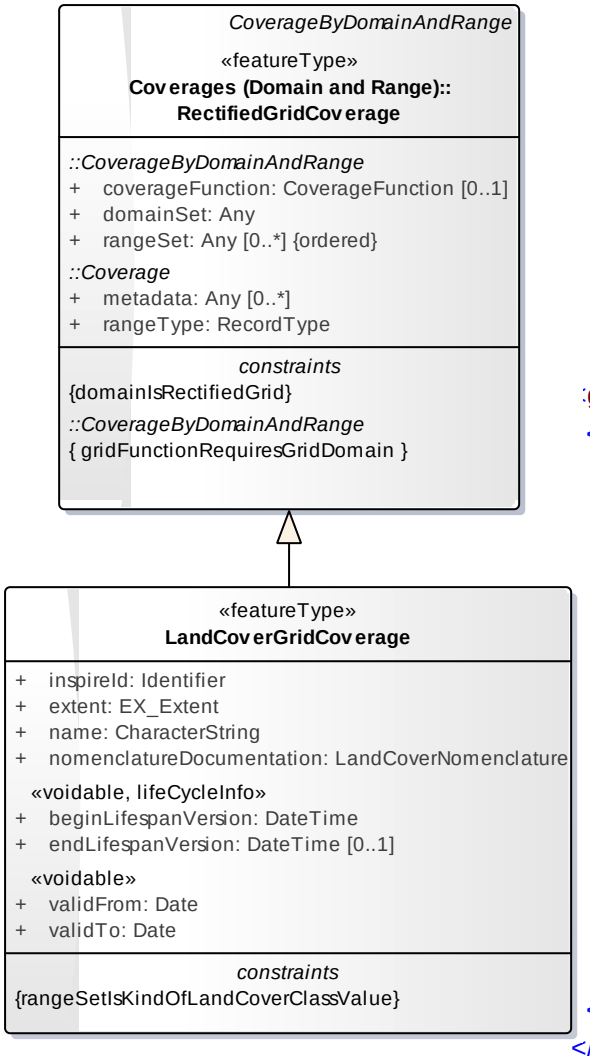
LandCoverGridCoverage feature type



Since Land Cover Raster application schema models Land Cover data as rectified grid coverages, the ArcFUEL spatial dataset has been mapped to the LandCoverGridCoverage feature type.

```
<?xml version="1.0" encoding="UTF-8"?>
<gml:FeatureCollection
  ……..
xsi:schemaLocation="http://inspire.ec.europa.eu/schemas/lcr/3.0
http://inspire.ec.europa.eu/schemas/lcr/3.0/LandCoverRaster.xsd"
gml:id="eu.Italy.Calabria.ArcFuel_FCM">
  <gml:featureMember>
    <lcr:LandCoverGridCoverage gml:id="ArcFuel.FCM.Calabria_LCRaster">
      ……
    </lcr:LandCoverGridCoverage>
  </gml:featureMember>
</gml:FeatureCollection>
```

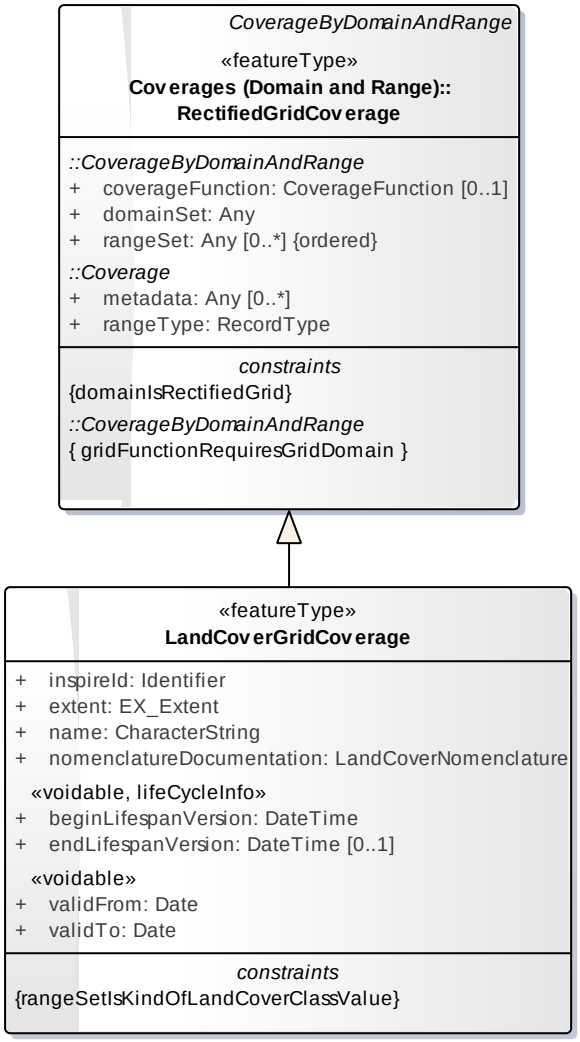
domainSet **attribute**



In accordance to the constraint '*domainIsRectifiedGrid*', present in the RectifiedGridCoverage feature type, the domain of the coverage (i.e. the *domainSet* attribute of the LandCoverGridCoverage feature type) has been encoded as RectifiedGrid.

```
:gml:domainSet>
 <gml:RectifiedGrid dimension="2" gml:id="tiff_domain">
  <gml:limits>
   <gml:GridEnvelope>
    <gml:low>550780 4190560</gml:low>
    <gml:high>695380 4452960</gml:high>
   </gml:GridEnvelope>
  </gml:limits>
  <gml:axisLabels>x y</gml:axisLabels>
  <gml:origin>
   <gml:Point gml:id="grid_origin_tiff" srsName="http://www.opengis.net/def/crs/EPSG/0/3045">
    <gml:pos>550780.00 4452960.00</gml:pos>
   </gml:Point>
  </gml:origin>
  <gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSG/0/3045">50 0</gml:offsetVector>
  <gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSG/0/3045">0 -50</gml:offsetVector>
 </gml:RectifiedGrid>
</gml:domainSet>
```

rangeSet attribute



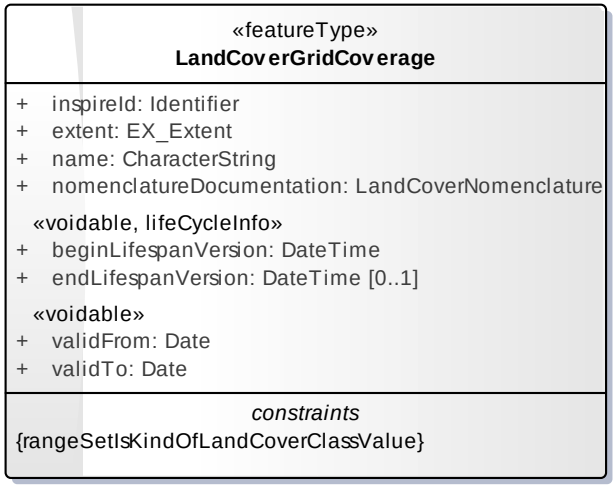
Considering that the final ArcFUEL output, is a file-based dataset, the range set of the coverage (i.e. value of the *rangeSet* attribute in the LandCoverGridCoverage feature type) has been encoded using an *xlink:href* attribute for referencing to the *tiff* file (Section D.4 of "D2.7: Guidelines for the encoding of spatial data, Version 3.3").

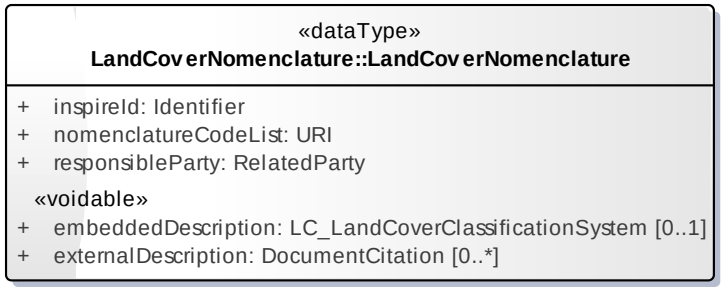
```
<gml:rangeSet>
 <gml:File>
  <gml:rangeParameters xlink:href="http://www.epsilon-italia.it/public/ArcFuel/Italy_Calabria.tif"/>
  <gml:fileReference>Italy_Calabria.tif</gml:fileReference>
  <gml:fileStructure>Record Interleaved</gml:fileStructure>
 </gml:File>
</gml:rangeSet>
```

Nomenclature encoding

- Regarding the FCM nomenclature, the element *nomenclatureDocumentation* of the featureType LandCoverGridCoverage has been used.

- Within its LandCoverNomenclature dataType, the attribute *nomenclatureCodeList* has been used to document the 20-classes Fuel Types classification defined by ArcFUEL, through its encoding as an URI.



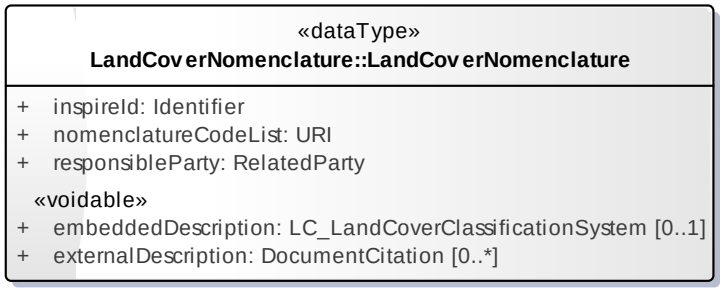


Nomenclature (codes and names) of the ArcFuel FCM

1	Evergreen Broadleaved Scrub forest	11	Deciduous Coniferous open forest
2	Evergreen Broadleaved open forest	12	Deciduous Coniferous Dense forest
3	Evergreen Broadleaved Dense forest	13	Evergreen Mixed Scrub forest
4	Deciduous Broadleaved Scrub forest	14	Evergreen Mixed open forest
5	Deciduous Broadleaved open forest	15	Evergreen Mixed Dense forest
6	Deciduous Broadleaved Dense forest	16	Deciduous Mixed Scrub forest
7	Evergreen Coniferous Scrub forest	17	Deciduous Mixed open forest
8	Evergreen Coniferous open forest	18	Deciduous Mixed Dense forest
9	Evergreen Coniferous Dense forest	19	Shrubs
10	Deciduous Coniferous Scrub forest	20	Grasses

Nomenclature encoding

- In addition, for the FCM nomenclature documentation, the attribute “externalDescription” of the LandCoverNomenclature dataType has been used, instead of the attribute ”embeddedDescription”, which should require using LCML metalanguage.




```
<lcr:nomenclatureDocumentation>
  <lcn:LandCoverNomenclature>
    <lcn:inspireId>
      <base:Identifier>
        <base:localId>forestFuelClasses</base:localId>
        <base:namespace>eu.arcfuel.fcm</base:namespace>
      </base:Identifier>
    </lcn:inspireId>
    <lcn:nomenclatureCodeList>http://www.epsilon-
        italia.it/public/ArcFuel/ArcFuel_forest_fuel_classes.pdf</lcn:nomenclatureCodeList>
    <lcn:externalDescription>
      <base2:DocumentCitation gml:id="dc_01">
        <base2:name>ArcFuel methodology for mapping forest fuels in Europe</base2:name>
        <base2:date>
          <gmd:CI_Date>
            <gmd:date>
              <gco:DateTime>2012-05-25T00:00:00.000</gco:DateTime>
            </gmd:date>
            <gmd:dateType>
              <gmd:CI_DateTypeCode codeListValue="creation"
              codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml"/>
            </gmd:dateType>
          </gmd:CI_Date>
        </base2:date>
        <base2:link>http://www.epsilon-italia.it/public/ArcFuel/ArcFuel method draft-AUTH-
            ALGO_25052012.pdf</base2:link>
      </base2:DocumentCitation>
    </lcn:externalDescription>
    <lcn:responsibleParty>
      <base2:RelatedParty>
        <base2:organisationName>
          <gco:CharacterString>Arcfuel project</gco:CharacterString>
        </base2:organisationName>
      </base2:RelatedParty>
    </lcn:responsibleParty>
  </lcn:LandCoverNomenclature>
</lcr:nomenclatureDocumentation>
```

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Dataset validation

- Full conformity w.r.t. the 7 tests of CC A.1 (Application schema) of ATS has been achieved and documented
- Detailed presentation will be given on Thursday 19.06.2014 at 10 am in Room 5: “How to Assess the Degree of Conformity to the Requirements Specified by Commission Regulation (EU) No 1089/2010 Relevant to a Dataset Belonging to INSPIRE Annex II/III Data Themes”

- This data harmonization exercise is fully documented in 3 Best Practices available in the smeSpire Best Practice Catalogue (www.smespire.eu):
  - How to encode a raster dataset in accordance to INSPIRE "D2.8.II.2 Data Specification on Land Cover – Technical Guidelines"
  - How to assess the degree of conformity to the requirements specified by Commission Regulation (EU) No 1089/2010 relevant to a dataset belonging to INSPIRE Annex II/III data themes
  - INSPIRE compliant metadata containing both discovery MD and MD for interoperability

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ArcFIRE.eu
Forest Fire Management System

- A state-of-the-technology Integrated Wildland & Forest Fire Management Platform under constant technology evolution since 1990.
- It is offered to Civil Protection Authorities, and National- Regional- & Local Authorities.
- Its aim is to guide operations and protect our forests.
- The platform is customizable to meet any client's needs

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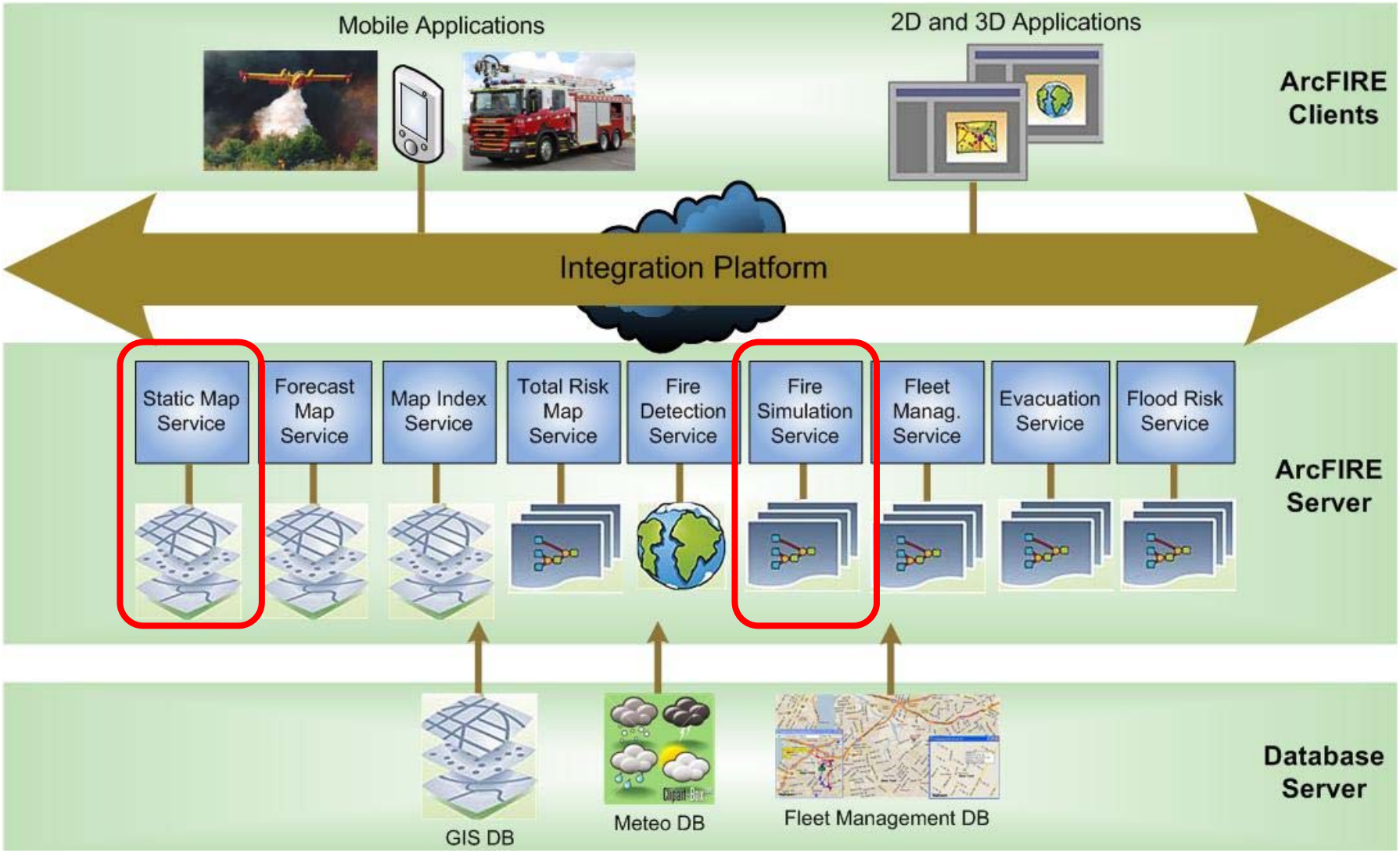
Forest Fire Management System



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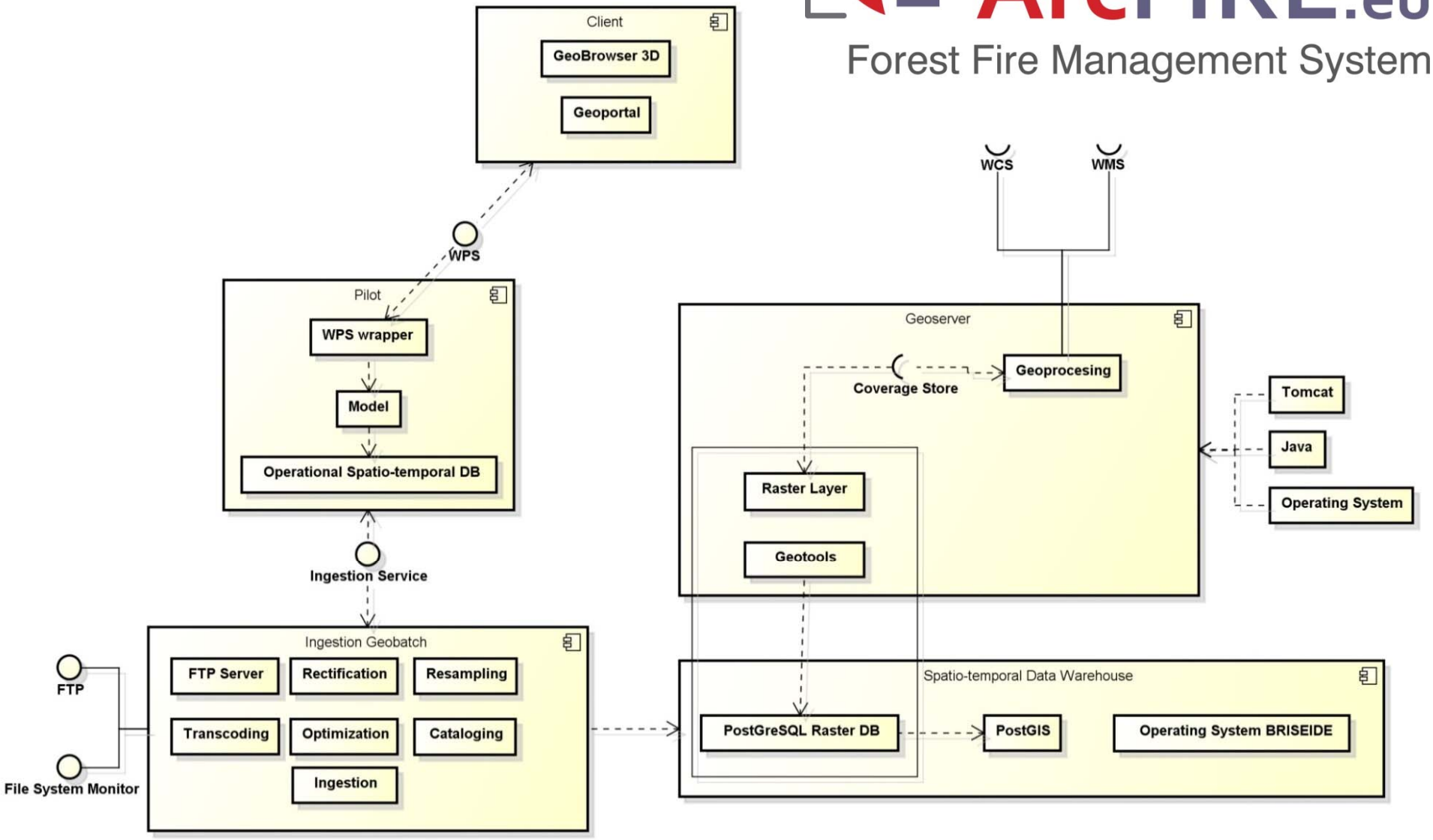
ArcFIRE.eu
Forest Fire Management System

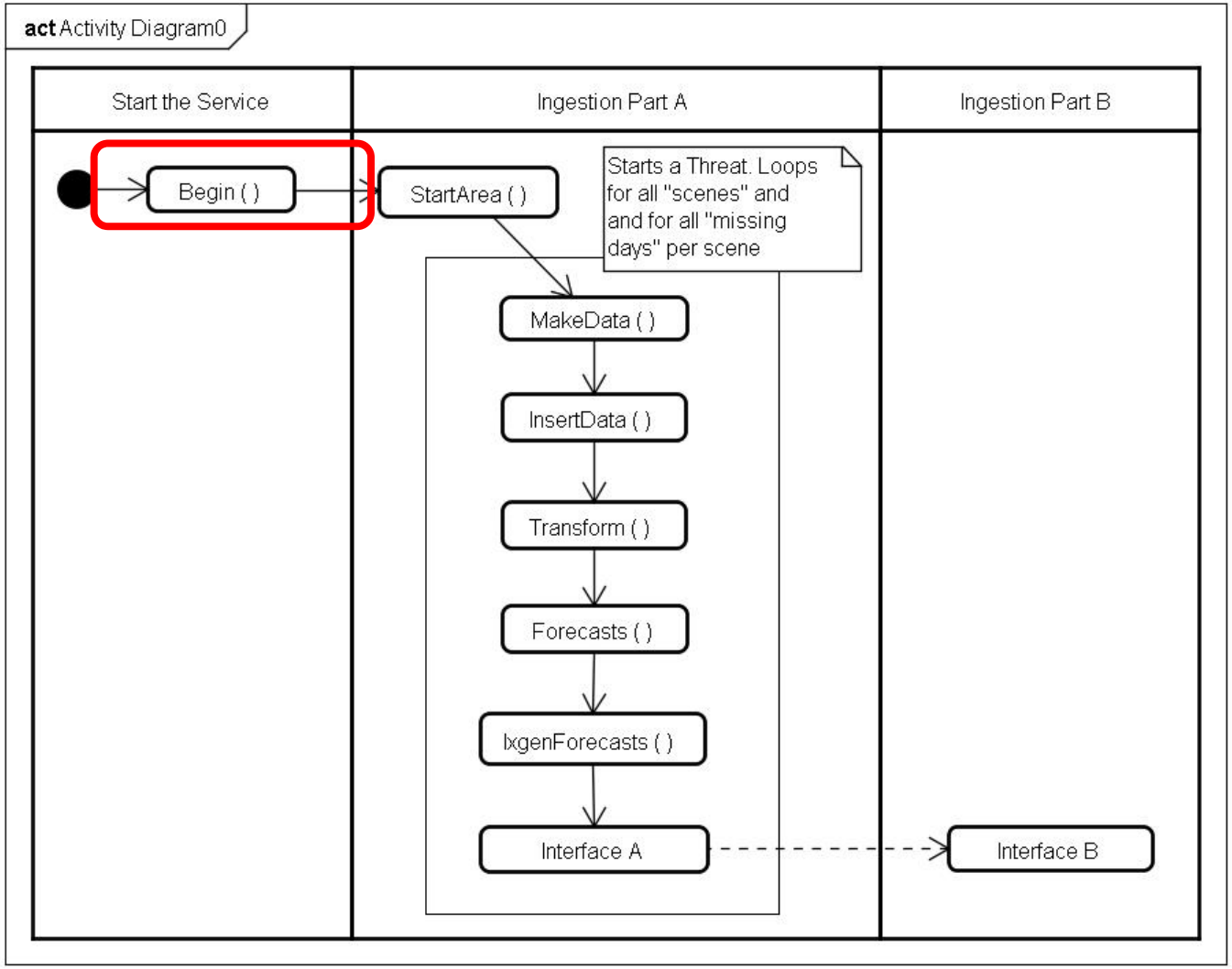
Technology:

- Asynchronous Ingestion Service
  - creation of spatio-temporal data (meteorological forecasts and indexes)
  - ingestion of data to the eENVplus SDI
  - return data via OGC sevices: WMS, WCS, WFS

- WPS orchestration
  - calculation of fire simulation (FAT: fire access time) - INSPIRE
  - calculation of total risk by combining a series of services
  - calculation of optimal route avoiding the fire


Client
GeoBrowser 3D
Geoportal
WPS
Pilot
WPS wrapper
Model
Operational Spatio-temporal DB
Ingestion Service
Ingestion Geobatch
FTP Server
Rectification
Resampling
Transcoding
Optimization
Cataloging
Ingestion
FTP
File System Monitor
WCS
WMS
Geoserver
Coverage Store
Geoprocesing
Raster Layer
Geotools
Tomcat
Java
Operating System
Spatio-temporal Data Warehouse
PostGreSQL Raster DB
PostGIS
Operating System BRISEIDE

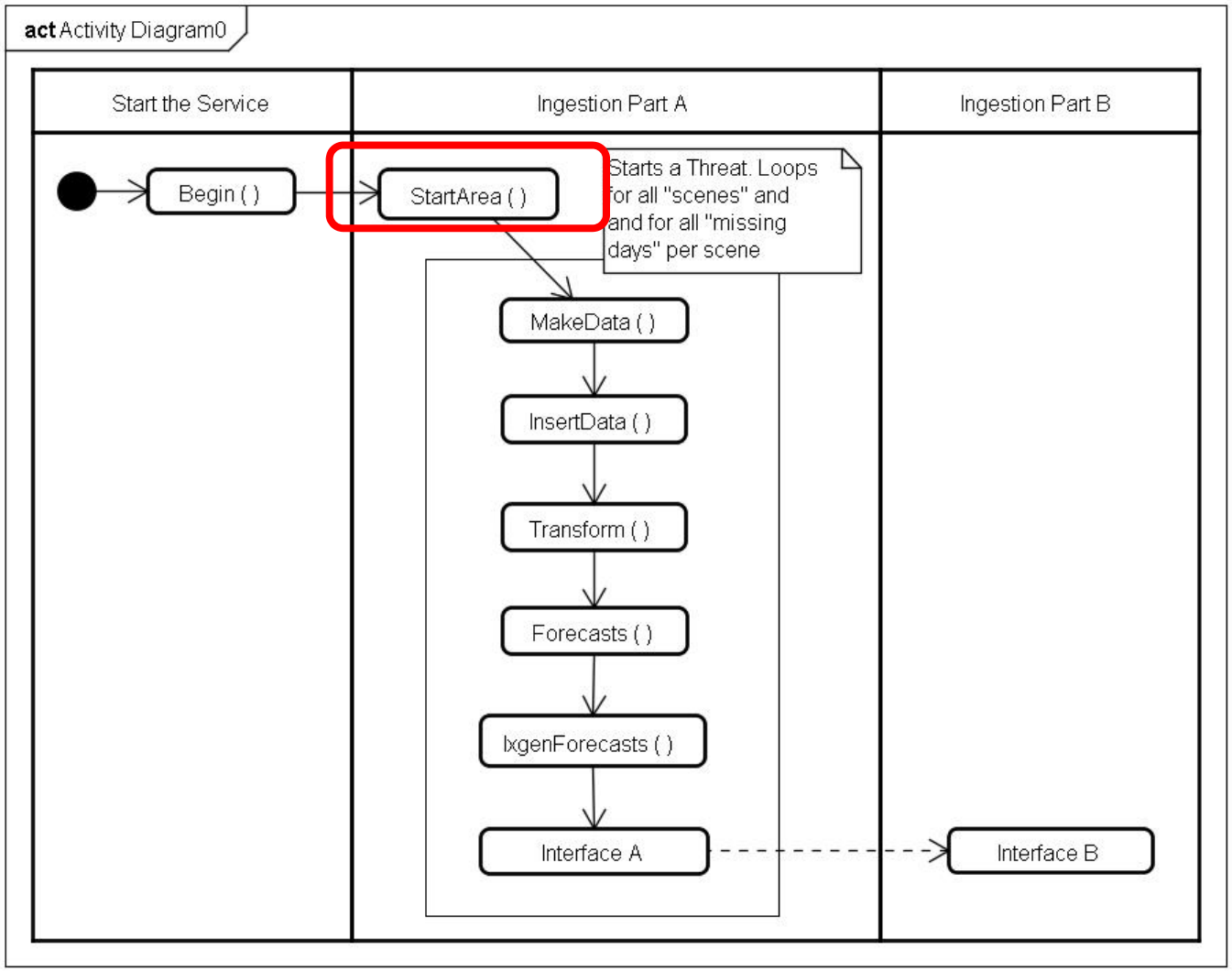
ArcFIRE Ingestion Service



ArcFIRE Ingestion Service

- Begin ()
  - sets the parameters to download the raw meteorological data for all the active pilot areas called “Scenes”
  - defines the BBOX with particular CRS and EGU (e.g. 20m.)
  - all available and activated “Scenes” are stored in an XML structure which contains only one data type called “Meteo Territory”
  - copies the XML attributes in the root directory of the machine where the service is running

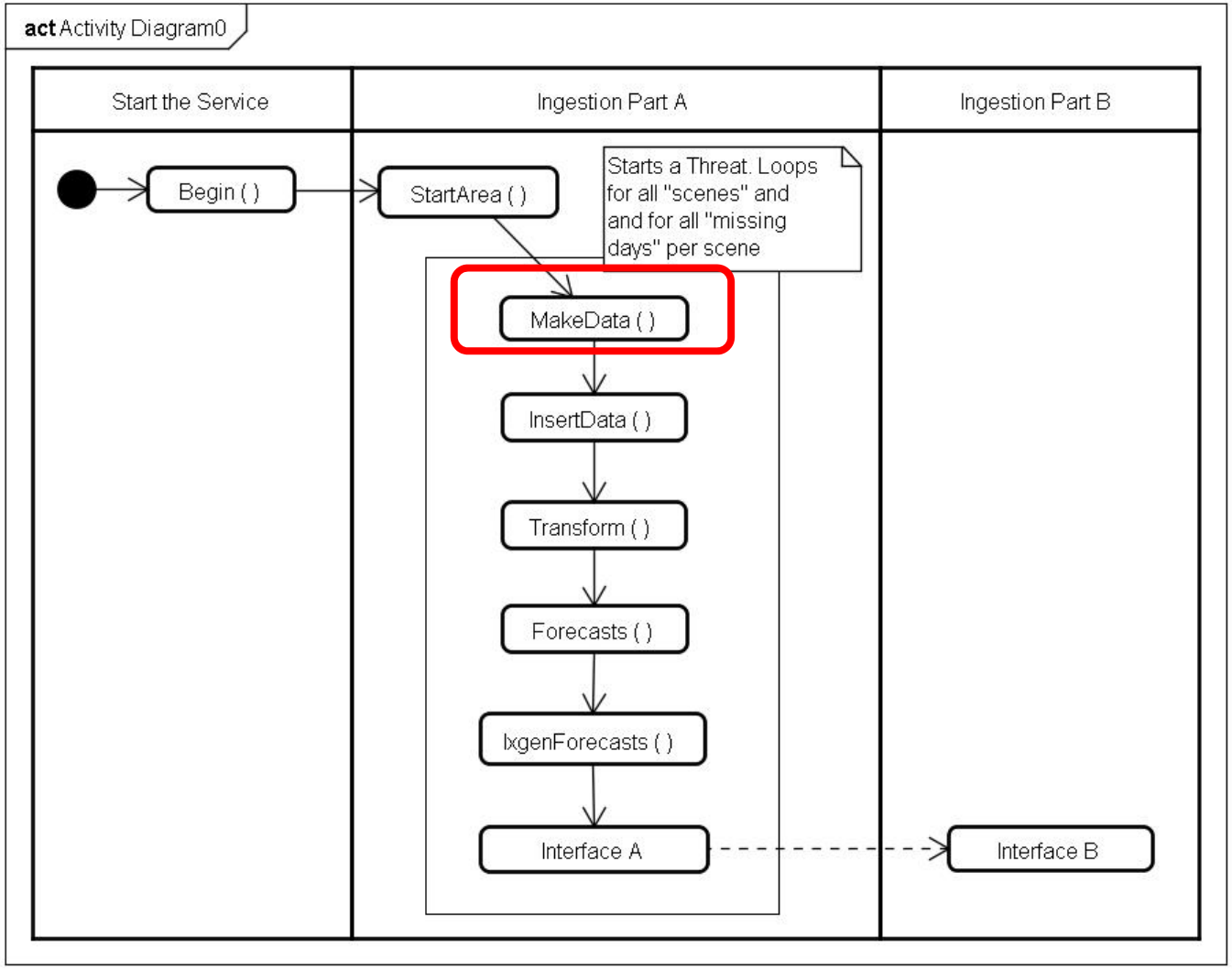
ArcFIRE Ingestion Service



ArcFIRE Ingestion Service

- Start Area ()
  - queries the FTP services given by the “Meteo Territory” in a sequential order (e.g. UoA)
  - if any problem occurs in the query, the function attempts after 10 min
  - if an FTP area fails to respond, the function searches for the next available FTP server
  - compares the “ddmmyy” folders available on the FTP folder structure against the sets of raw data already downloaded
  - starts a threat for each day missing and is not prior to “Server installation date” or the “last backup date”

ArcFIRE Ingestion Service



ArcFIRE Ingestion Service

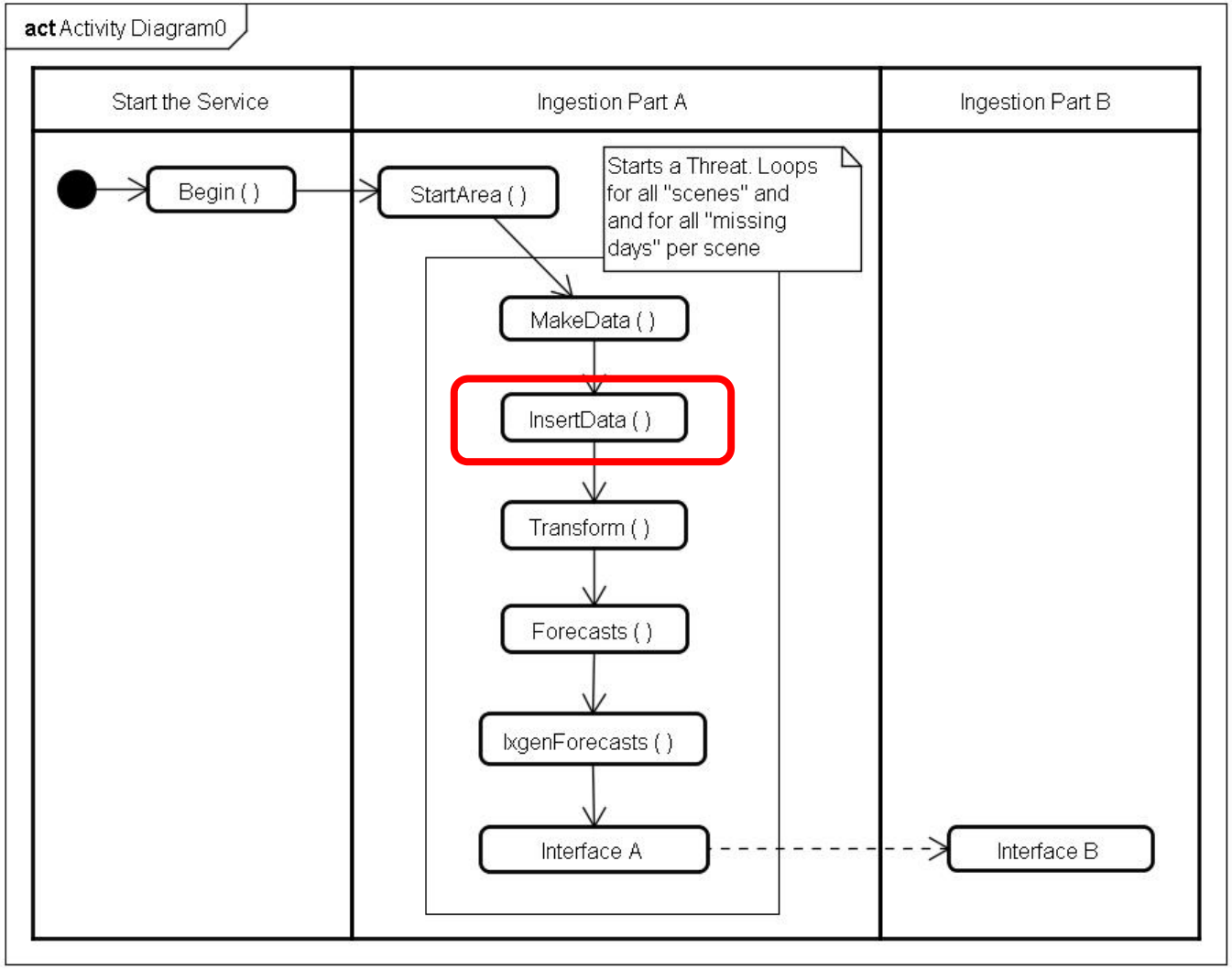
Περιεχόμενα φακέλου

ftp://ftp.mg.uoa.gr/incoming/seihsou/010110/

Όνομα	Τύπος	Μέγεθος	Χρόνος
SEIHSU_LL.000	Αρχείο 000	32 KB	1/1/2010 12:00:00 πμ
SEIHSU_LL.001	Αρχείο 001	32 KB	1/1/2010 12:00:00 πμ
SEIHSU_LL.002	Αρχείο 002	32 KB	1/1/2010 12:00:00 πμ
SEIHSU_LL.003	Αρχείο 003	32 KB	1/1/2010 12:00:00 πμ
SEIHSU_LL.004	Αρχείο 004	32 KB	1/1/2010 12:00:00 πμ
SEIHSU_LL.005	Αρχείο 005	32 KB	1/1/2010 12:00:00 πμ
SEIHSU_LL.006	Αρχείο 006	32 KB	1/1/2010 12:00:00 πμ
SEIHSU_LL.007	Αρχείο 007	32 KB	1/1/2010 12:00:00 πμ
SEIHSU_LL.008	Αρχείο 008	32 KB	1/1/2010 12:00:00 πμ
SEIHSU_LL.009	Αρχείο 009	32 KB	1/1/2010 12:00:00 πμ
SEIHSU_LL.010	Αρχείο 010	32 KB	1/1/2010 12:00:00 πμ

- MSL: mean sea-level pressure (Pa)
- RAIN: accumulated precipitation for the last 1h (mm)

ArcFIRE Ingestion Service

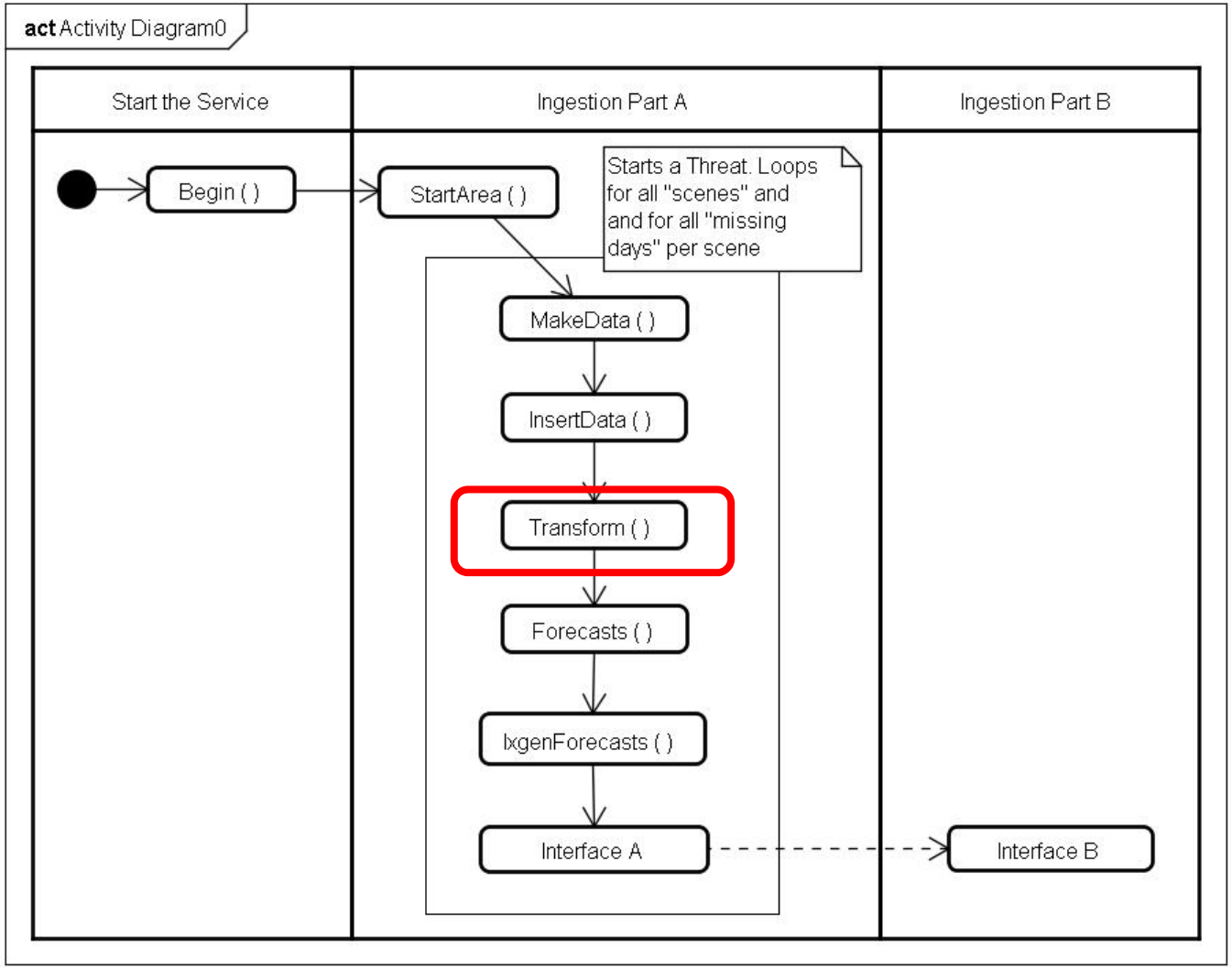


ArcFIRE Ingestion Service

- Insert Data ()
  - parses all the files 1-by-1 per day available
  - separates the file in 7 blocks (one for each parameter)
  - Stores the data into the database (PostGIS)

U10			V10		
43.05000	16.25000	-6.421691	43.05000	16.25000	4.696099
43.05000	16.30000	-6.457536	43.05000	16.30000	4.403107
43.05000	16.35000	-6.510066	43.05000	16.35000	4.069227
43.05000	16.40000	-6.572003	43.05000	16.40000	3.720452
43.05000	16.45000	-6.495194	43.05000	16.45000	3.239167
43.05000	16.50000	-6.255976	43.05000	16.50000	2.421854
43.05000	16.55000	-5.981557	43.05000	16.55000	1.219716
43.05000	16.60000	-5.560592	43.05000	16.60000	8.2355142E-03
43.05000	16.65000	-5.352507	43.05000	16.65000	-0.7028813
43.05000	16.70000	-5.281198	43.05000	16.70000	-1.087345
43.05000	16.75000	-5.349058	43.05000	16.75000	-0.7199348
43.05000	16.80000	-5.518385	43.05000	16.80000	-2.2914171E-02
43.05000	16.85000	-5.525542	43.05000	16.85000	0.1791499
43.05000	16.90000	-5.250029	43.05000	16.90000	0.1292210
43.05000	16.95000	-5.191285	43.05000	16.95000	2.9865503E-02
43.05000	17.00000	-5.138137	43.05000	17.00000	-0.1486912
43.05000	17.05000	-5.143550	43.05000	17.05000	-0.2149214
43.05000	17.10000	-4.976244	43.05000	17.10000	-0.1832494
43.05000	17.15000	-4.257140	43.05000	17.15000	-8.2013965E-02
43.05000	17.20000	-3.607817	43.05000	17.20000	3.1595100E-02
43.10000	16.25000	-6.438410	43.10000	16.25000	4.747495

ArcFIRE Ingestion Service



ArcFIRE Ingestion Service

- Transform ()
  - **Wind Speed (WSP) transformation**
    - transforms U10 (x component, m/s) and V10 (y component, m/s) to WPS (m/sec)

$$WSP = \sqrt{U10^2 + V10^2}$$

  - **Wind Direction (WDI) transfrmation**
    - transforms U10 (x component, m/sec) and V10 (y component, m/sec) to WDI (degrees)

$$\tan\theta = \frac{x}{y} = \frac{U10}{V10} \Rightarrow \theta = Arc\tan\frac{U10}{V10}$$

ArcFIRE Ingestion Service

- Transform ()
  - **Temperature (TEM) transformation**
    - Transforms T2M (Kelvin) to TEM (Celsius)

$$TEMCelsius = TEMKelvin - 273.15$$

  - **Rain precipitation (PPD) transformation**
    - transforms RAIN (rain precipitation per hour, mm) to PPD (rain precipitation per day, mm) >> 5 PPD files are produced

$$PPD_{001-012} = PPH_{001} + PPH_{002} \ldots + PPH_{012}$$

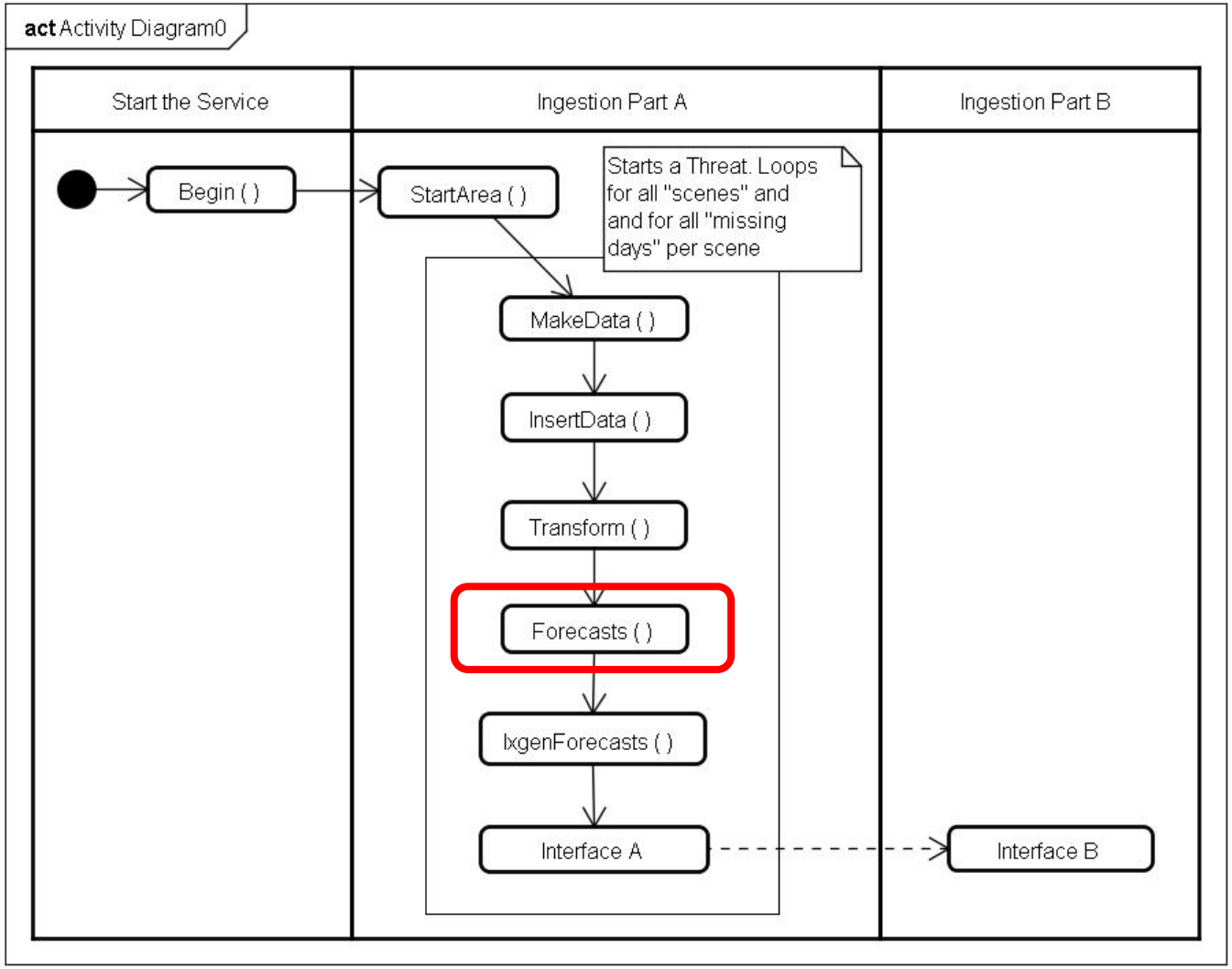
$$PPD_{013-036} = PPH_{013} + PPH_{014} \ldots + PPH_{036}$$

$$PPD_{037-060} = PPH_{037} + PPH_{038} \ldots + PPH_{060}$$

$$PPD_{061-084} = PPH_{061} + PPH_{062} \ldots + PPH_{084}$$

$$PPD_{085-108} = PPH_{085} + PPH_{086} \ldots + PPH_{108}$$

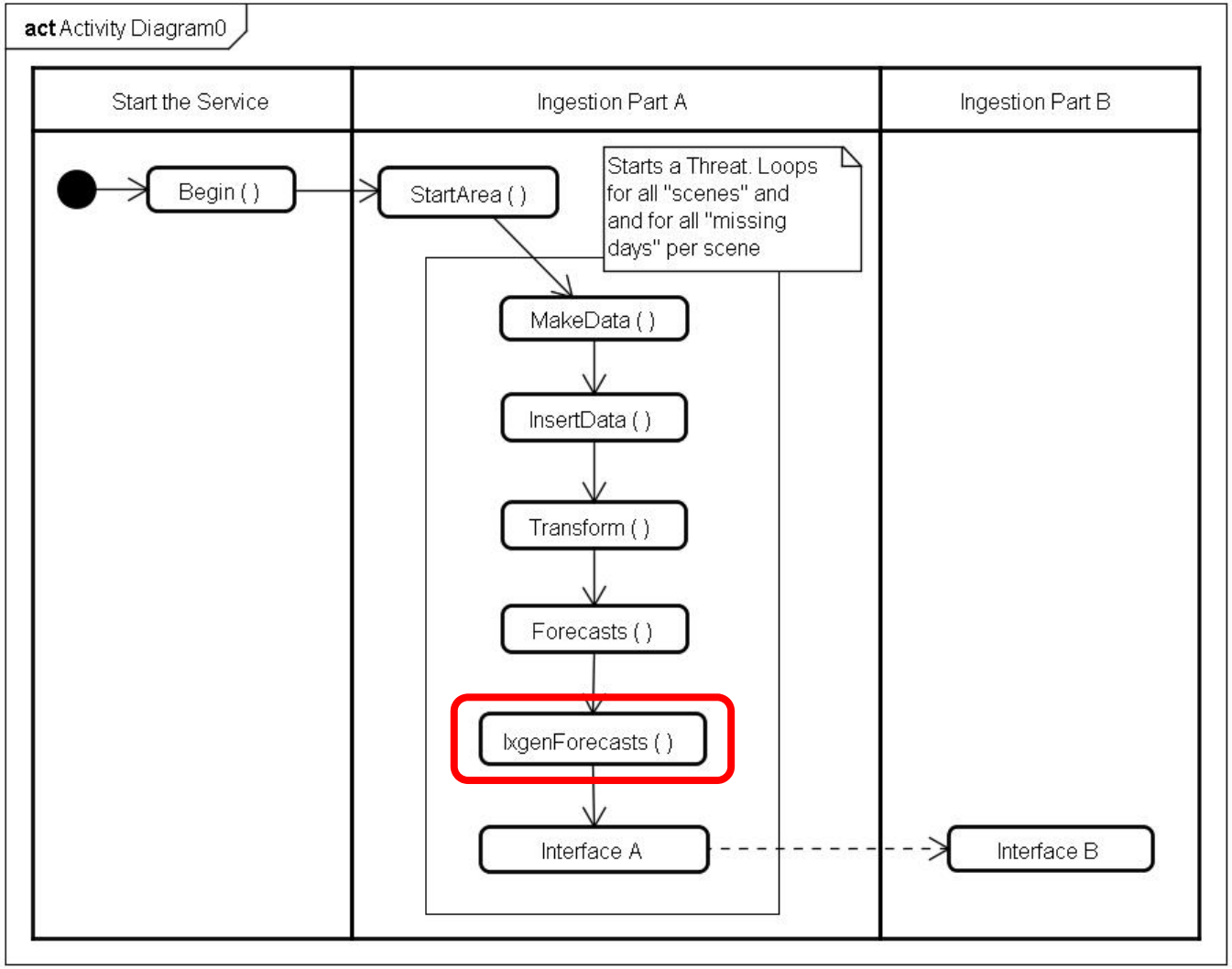
ArcFIRE Ingestion Service



ArcFIRE Ingestion Service

- Forecasts ()
  - georeferences the raw data to forecast maps
  - resample data at higher resolution (e.g. from 1km to 20m to make them operational at regional level)
  - creates 7 sets of 121 ascii files and stores them to the DB
  - follows the name convention SSS_YYYMMDDHHNN_hhh_XXX
    - SSS: scene identifier (e.g. 001)
    - YYYY: year
    - MM: month
    - DD: day
    - HH: hour
    - NN: minutes
    - hhh: forecast identifier (e.g. 001 to 121)
    - XXX: code identifier for each parameter (e.g. WSP)

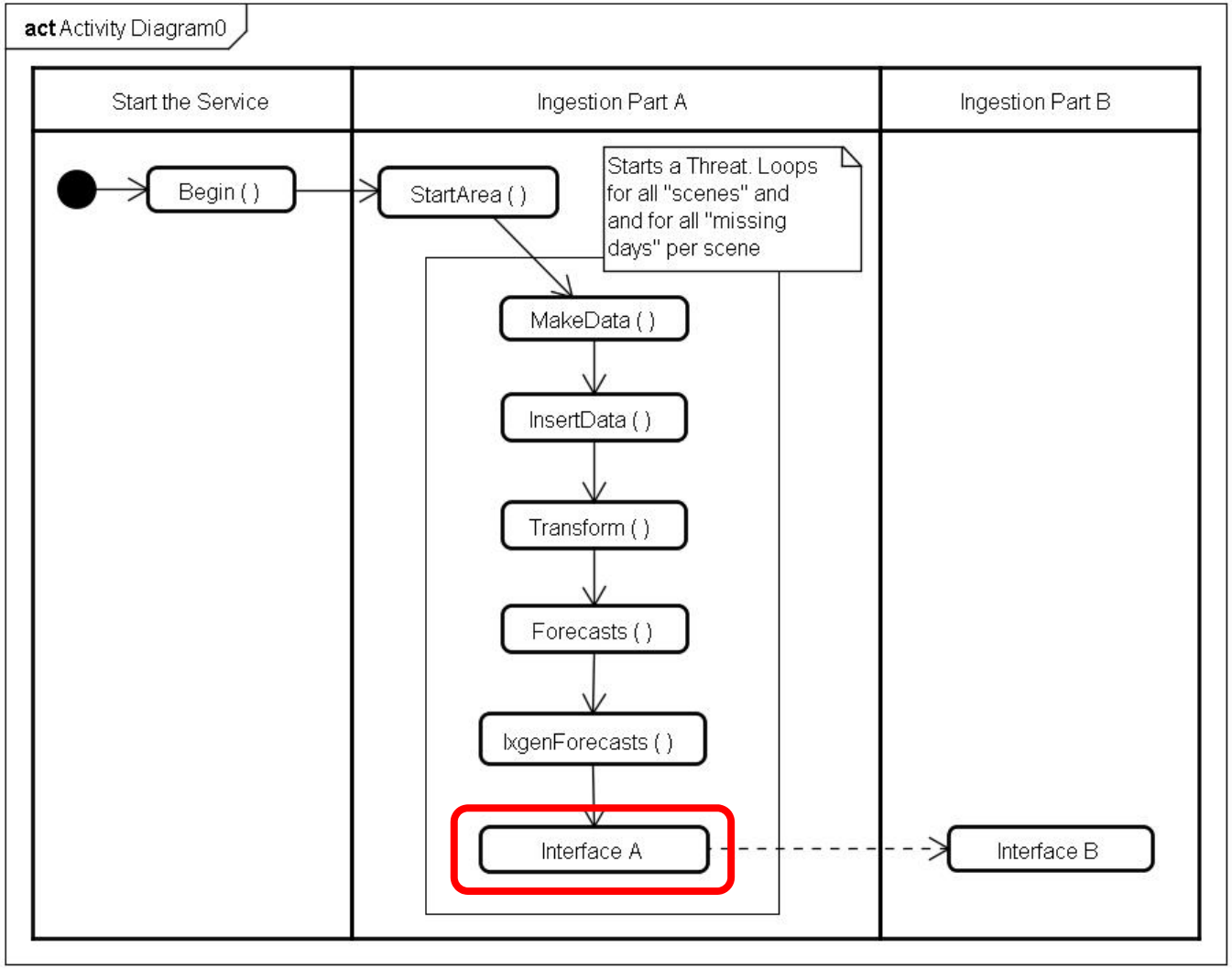
ArcFIRE Ingestion Service



ArcFIRE Ingestion Service

- Ixgen ()
  - creates 8 meteorological indexes related to forest fires
  - stores the indexes into the database
  - follows the name convention SSS_YYYMMDDHHNN_hhh_XXX
    - SSS: scene identifier (e.g. 001)
    - YYYY: year
    - MM: month
    - DD: day
    - HH: hour
    - NN: minutes
    - hhh: forecast identifier (e.g. 001 to 121)
    - XXX: code identifier for each parameter (e.g. WSP)

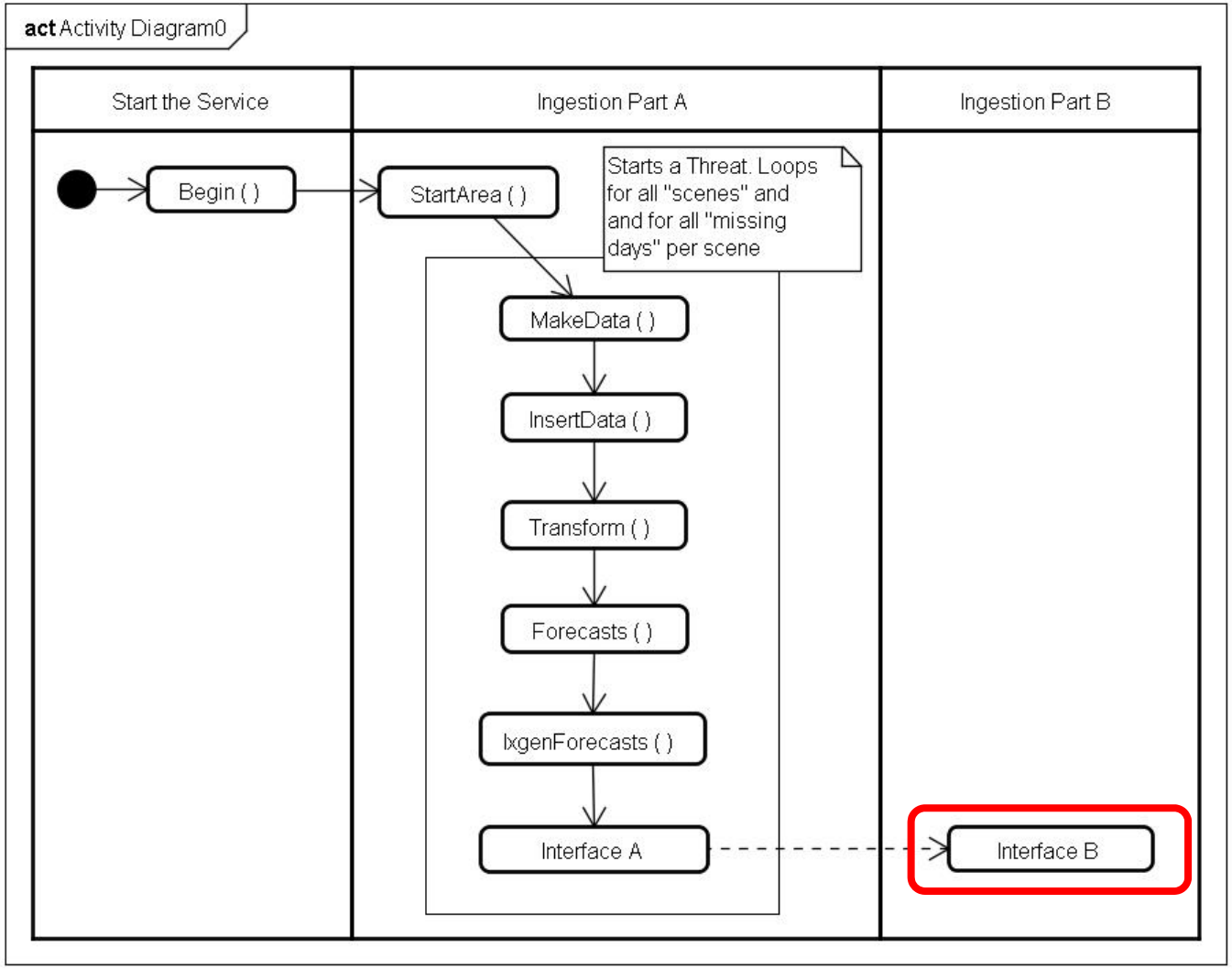
ArcFIRE Ingestion Service



ArcFIRE Ingestion Service

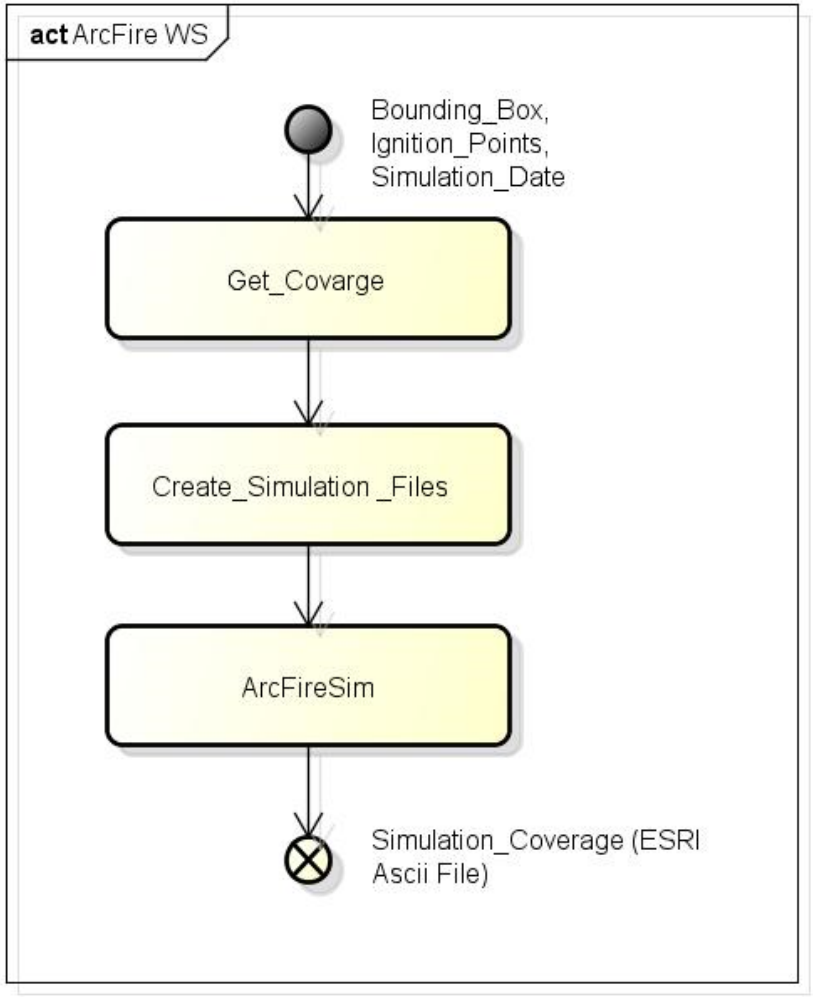
- Interface A () → Geobatch
  - collects the categories, zips the packages and sends them to the eENVplus Geoserver
    - BYR: fire maximum linear intensity, KW/m
    - CLO: cloud coverage (%)
    - DFM: dead fuel moisture (%)
    - HRE: air relative humidity (%)
    - PIG: probability of ignition (%)
    - PPD: air precipitation per day (mm)
    - PPH: air precipitation per hour (mm)
    - TEM: air temperature (celsius)
    - WDI: wind direction (degrees)
    - WSP: wind speed (m/sec)

ArcFIRE Ingestion Service



ArcFIRE Web Service

- Defines the BBOX, the ignition points and the simulation date
- Requests the necessary data using a WCS GetCoverage request
- Creates the simulation folders
- Runs the ArcFireSim
- Produces the simulation coverage output

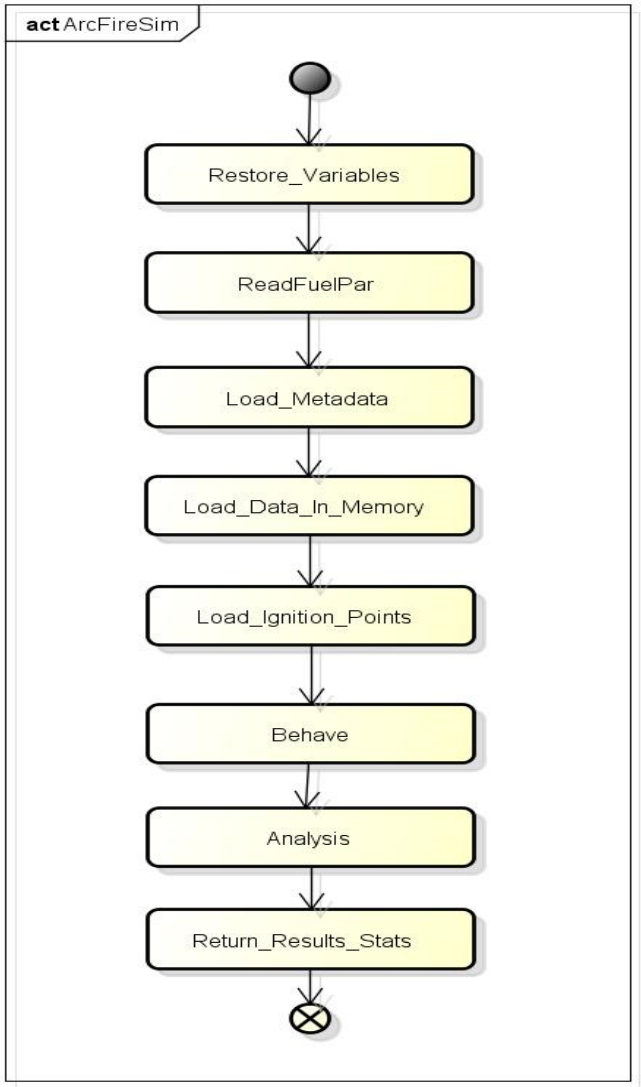


eENVplus

ArcFIRE.eu
Forest Fire Management System

ArcFIRESim

- restores the variables
- reads fuel parameters -INSPIRE
- loads the metadata in memory (reads the files ASP, SLO, FMO, DFM, WDI, WSP)
- loads ignition points
- Behave () does all the pre-calculation for all fuel models
- Analysis () does the cellular automatic analysis process
- returns the results and statistics



Thank you!

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