COLLABORATIVE ITS SERVICES VIA DATEX II

Document Control Information

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Summary

Introduction

Background

In the framework of Easyway Program ESG2 Traffic Management Systems (TMS) group, a supporting action was created to analyze the viability of the use of DATEX II in Traffic Management Plans. This work was initiated as joint task of ESG2 group TMS and ESG5 DATEX II.

The activity had been further developed in a coordinated way between: the TMS-SA03 "DATEX II and TMPs" and the Activity 5.3 "Support to TMPs" from ESG5.

A starting point for this activity had been the discussion in ESG2 which delivered EasyWay DeploymentGuidelines which described the procedure to design and implement Traffic Management Plan, with some hints to model this by main definition of relative concepts, such as Measure, Action, TMP Design and Implementation. This work is a prerequisite to properly understand and evaluate the current model implementation. Easyway 2012 edition of Deployment Guidelines can be downloaded from http://dg.its-platform.eu/DGs2012.

From ESG5 WI5.3 a proposal to manage Traffic Management Plans by DATEX II had been presented to EGS2 Technical Group in 2011-2012; other stakeholders had started reviewing it and proposed improved models to manage this run in a pilot implemention (e.g. IT DATEX group lead to a public available extension for TMPs which is available at DATEX website (http://www.datex2.eu/content/vms-operational-exchange-and-tmp-management).

After that in European ITS Platform EIP frame in 2014-2015, the DATEX SG group launched a Collaborative ITS Service (CIS) Work-Item to analyze and integrate in the DATEX Model information required to manage workflow aiming to implement Traffic Management Plan as a specific case of implementing any kind of **Collaborative ITS Service**, as explained further in this document.

The outcome of 2015 CIS activity has been carried on and reviewed by current DATEX TMG group and is now delivered as DATEX II group released Extention of DATEX II version 2.3 model and will be included with possible improvements and amendments in further versions. For version 3.0 it will be managed according the updated methodology taking into account all updated specification and new reference normative which will be applicable.

NOTE. referring a single "Traffic Management Plan" an acronym "TMP" could be used. DATEX group preferred to use TMPlan which will be used further in this document.

Document Structure

This document contains the following sections

Collaborative ITS Use Case Description: with reference to Exchange patterns this section describes the Business Case of CIS out of simple Information Delivery Use Case which had normally been considered in the DATEX Exchange domain. Conceptual modelling and definition are given in order to adequately frame the user requirements based on DATEX Model Driven approach.

CIS and TMPlan model Extension: describing the implementation of CIS requirements based on Information Delivery pattern exchange and DATEX II version 2.3 model implementation.

Main results of this work have been achieved as result of 2015 Activity on Collaboration ITS Services under EIP 4.5 Sub-Activity DATEX II.

Countries which contributed to this work: IT (lead), PT, NL, UK, ES, SE, DE, GR, RO.

Collaborative ITS Services Use Case Description

Service Oriented vs. Information Delivery Oriented Information Exchange

The aim of Traffic areal time information exchange among Traffic Information and Traffic Control Centres are:

- to inform the Traffic Control Centre Operators of the situation that is being taken in the near area in order to help evaluate and prevent impact that may affect its competence.

- to request for information processing and delivery of services based on such exchanged information by the Client Centre, in order to support operational decisions and consequent implementation of operations and/or to inform drivers about safety and security behavior for drivers who are approaching a specific reported situation location.
    - Via broadcast and personalized Information channels (Radio, Bulletins, Call Centers, RDS-TMC Channel, web, etc.)
    - Via Variable Message Signs

The first case is the plain Information Delivery Business Case, in which the only scope is Data Delivery itself and any further processing objective consideration is out of scope. Data are delivered with only request to be received and in most of implementations they are only syntactically checked.

This communication model applies when a center can ignore for its objectives the final usage and processing outcomes which are derived from the information which is exchanged. This communication pattern has been fully addressed and described in **Data Delivery** communication pattern for DATEX II data exchange specification.

Considering the whole process chain to transfer information gathered from a system to another system, the data delivery section is contained in the chain from the information supplier to the receiver node of a DATEX II System

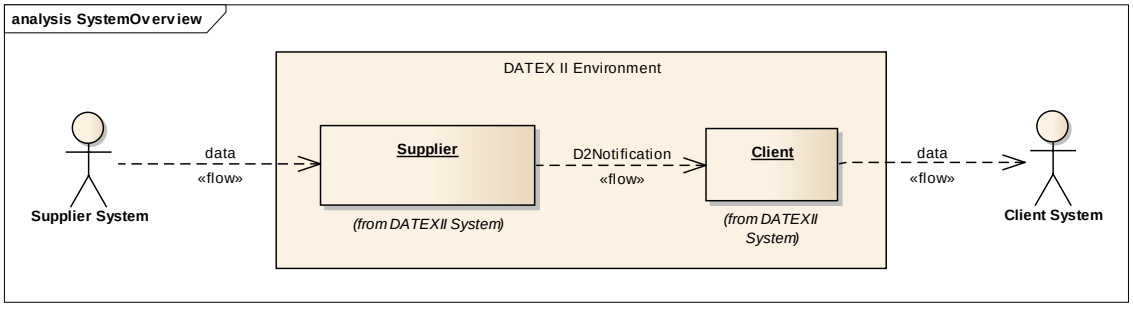


Fig. 1 - Boundary of DATEX system boundaries in Centres Information Delivery Business case

The only objective of Data delivery is to monitor that information delivered has been received correctly by the Client.

Introducing MMI as Man-Machine Interface i.e. the TCC Management Systems used by the Operator the chain of information among all the systems may be described as follows

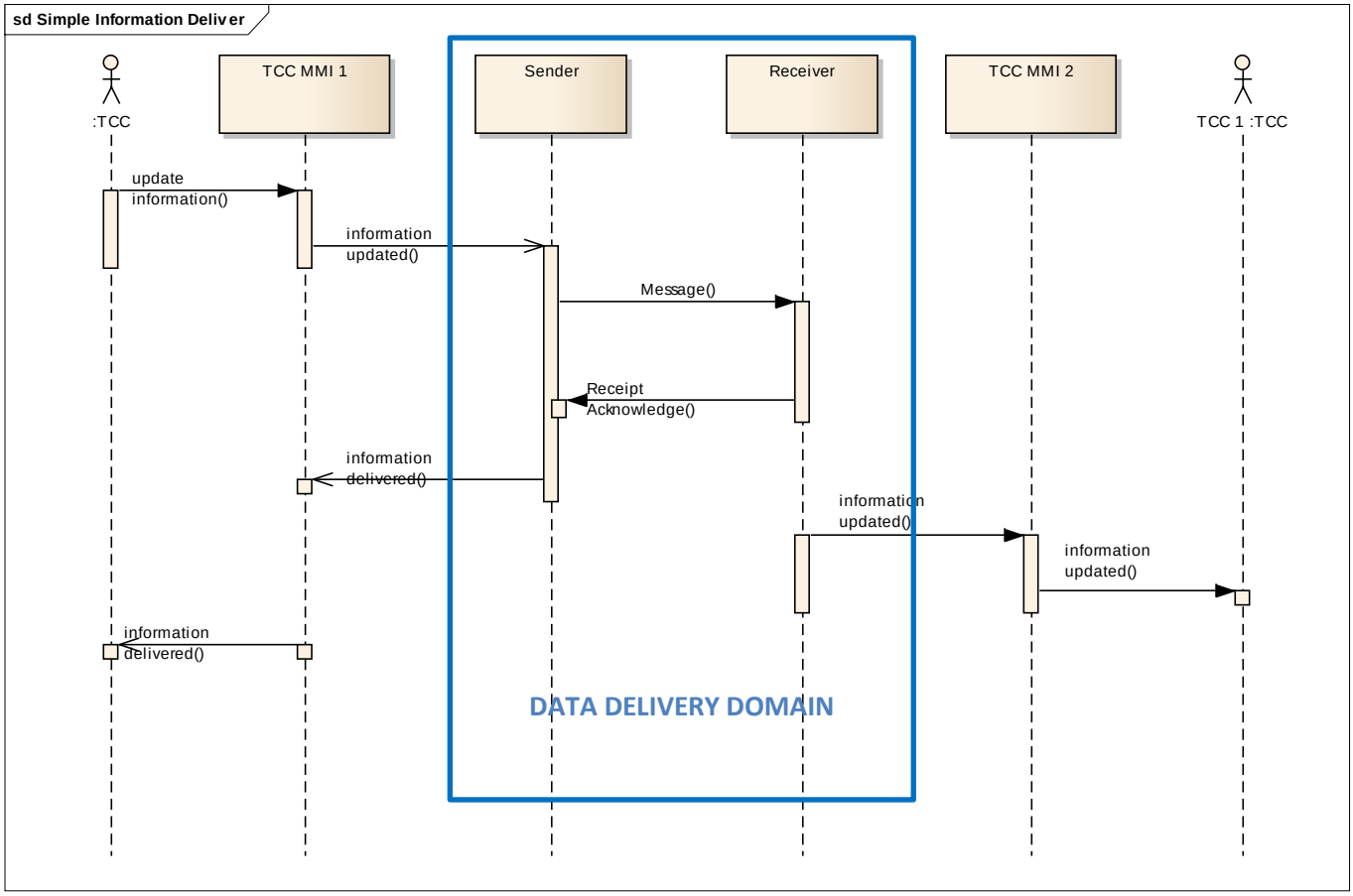


Fig. 2 - Boundary of DATEX system boundaries in Centres Information Delivery Business case

Considering this framework, as specified in the latter case mentioned before, we can consider that Information is not exchanged with the simple aim of **deliverying** it to other centres for their internal usage, but with the scope it will be used at the centre to implement processing and further services to be consumed by other applications and systems.

To activate a processing based on those data information need to be checked and not only Syntactical but also Semanthic errors are relevant to the processing. Furthermore Check and Processing Results, i.e. a **Feedback**, is fundamental.

In some use cases distributed processing and services have to be activated as a consequence of the validity of a certain information such as a Traffic Status or a High Impact Condition which is running on the road (e.g. Traffic Element, Road or Weather or Environmental condition). Management of such conditions by the Centres may imply the need for one or more operation to be executed (i.e. **services**) by several Traffic Management or Service Provider Centres, for instance based on predefined Traffic Mangement Plan which had been elaborated

for such conditions. This can happen also in case of extraordinary needs due to unpredictable events occurring in the road network which can affect the road operations (such as major Events and Activities).

In this case a more complex workflows is implemented by the several nodes involved. The outcomes of proposal acknowledging and operation implementing is needed to all involved nodes to have evidence of ongoing operations.

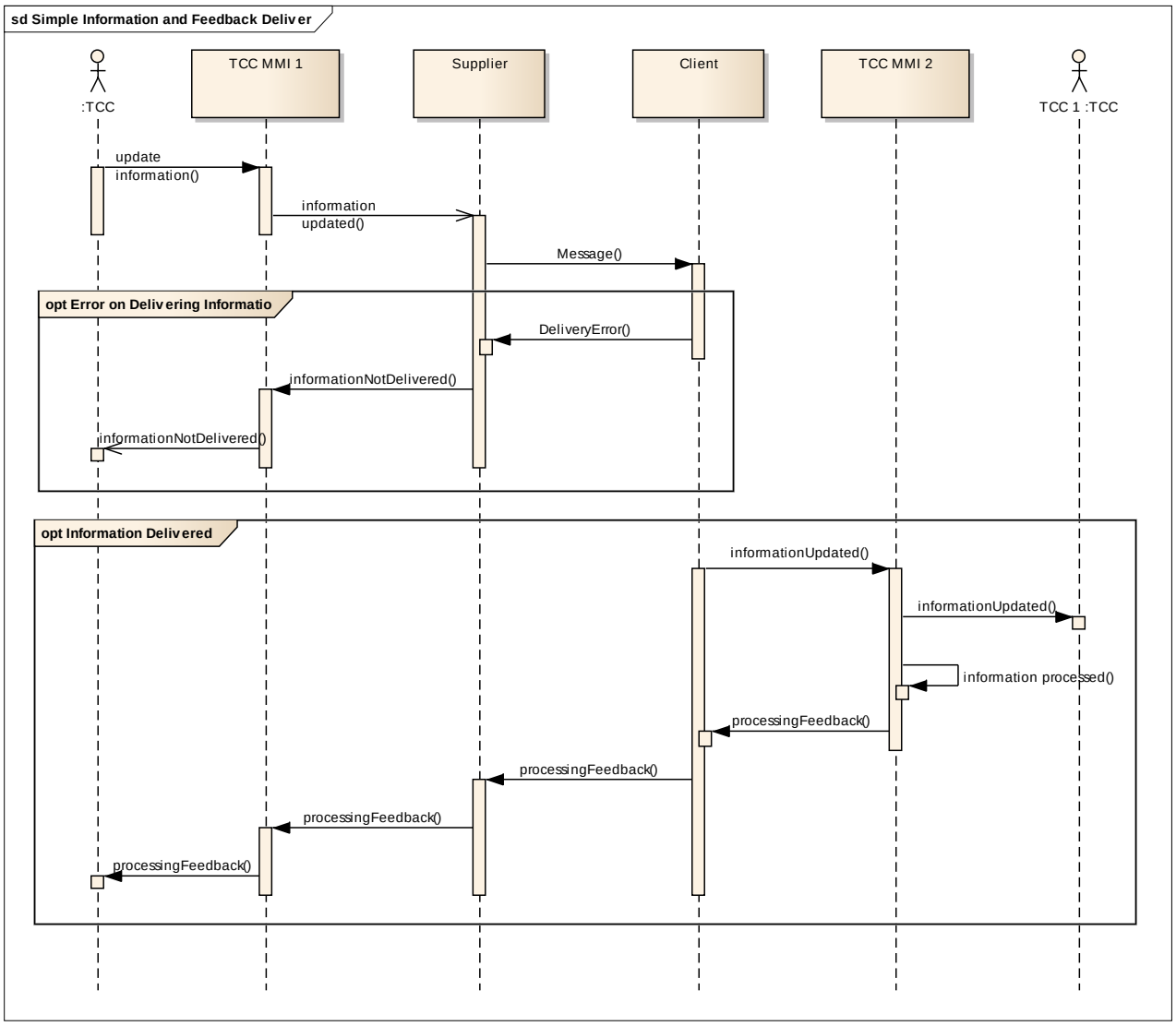


Fig. 3 - Example of Collaborative ITS Services business case framework

"**Collaborative ITS Services**" (**CIS**) explores the user requirements and common techniques to address the needs and implement collaborative services by centres and is based on exchanging information to be processed by other nodes and receive this processing outcomes (Feedback), giving a base to build more sophisticated workflows enabling to **cohordinate distributed operation among multiple centres**.

A "**Collaboration Workflow"** may be seen as a composition of one or more sequences of

- Service Request (based on exchanged Payload)
- Processing Results (Feedback)

among a pair or more of interoperating nodes.

These “Request and Feeback” brick sequences enable to set up a Workflow, where Application Level rules can be added in very structured configuration management

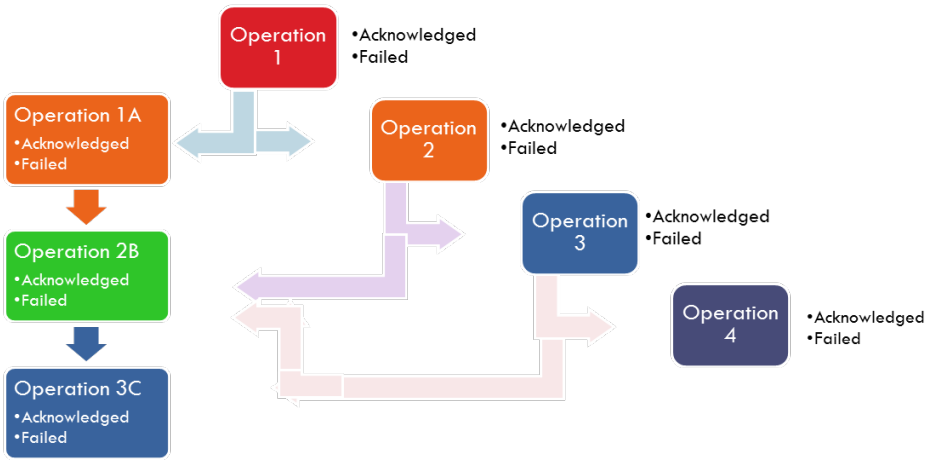


Fig. 4 - Example of ITS collaborative services Workflow

In this vision DATEX Exchange acts as an Operational tool enabling to take shared decisions and implement and monitor shared actions by the CIS Collaborative Services Pattern which is described in the following chapters.

CIS and TMPlan Design

For Traffic Management Plan (TMPlan) definitions as well as design and operating concepts we refer to Easyway TMS Deployment Guideline (ref. http://dg.easyway-its.eu/DGs2012)

TMPlan may be seen in a more general vision as Road Network Configuration implemented by means of resources because of a Scenario which conditions the road network status. The management of TMP aims to improve the poorer status of the network (Level of Service - LOS) and achieve better Global and/or Local specific performances, which are based in term of Traffic Flow Enhancement, Safety and Security performance and Pollution reduction.

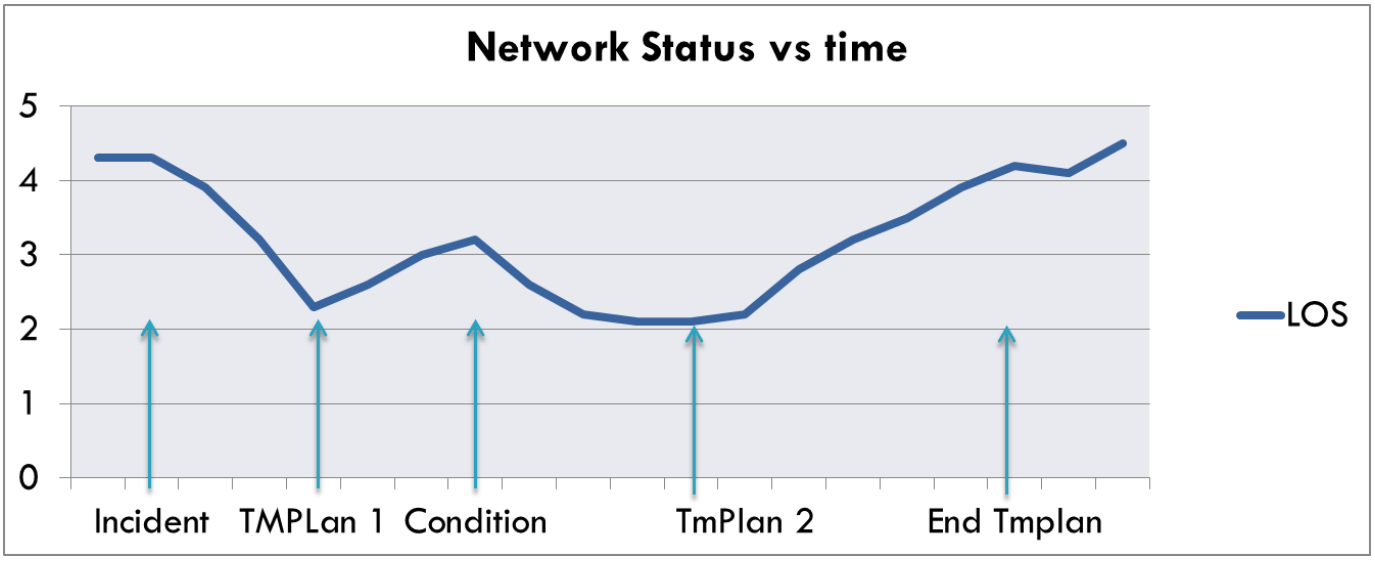


Fig. 5 – Network Status (LOS) during Incidents and Conditions and TMPlan operating on Road Network

The figure describes operating TMPlan during time having Incidents or Road Conditions which impact on Road Network Level of Service, seen as a global indicator. Operating TMPlan management improves LOS and achieve better performances.

Extending TMPlan approach description, we may see any option for resource usage across the road network, such as commanding a Variable Message Sign or controlling a whole section of a Lane Control System as well as Traffic Lights in Urban Area, as a Service offered by a Road Operator or TCC Operator to improve the road network performance as specified above.

Based on experience about road conditions and frequency of situation occurring, Traffic Engineers may design solutions to cope with problems which frequently arouse in road operation. We can depict a CIS Design generalizing TMPlan design expressed in Easyway TMS DG, as shown in the following figure.

It starts with a description of the Business Scenario i.e. the road Incidents or Conditions which have impact on the road network that are to be managed, then defining the problem to which it is related which has to be solved by the resources owned or managed by several organization. After a Feasibility Study and subsequent

discussion Traffic Engineers defines a CIS (TMPlan) Design to cope up with the problem, which describes the resource configuration options to be used. Sometimes more than one configuration is possible to achieve same result and this general result is named as Strategy . All possible Measure to realize a strategy are inventored. That CIS Design then define a CIS Activation Contract which states all details and rules to exchange and make decision to operate the CIS (TMPlan).

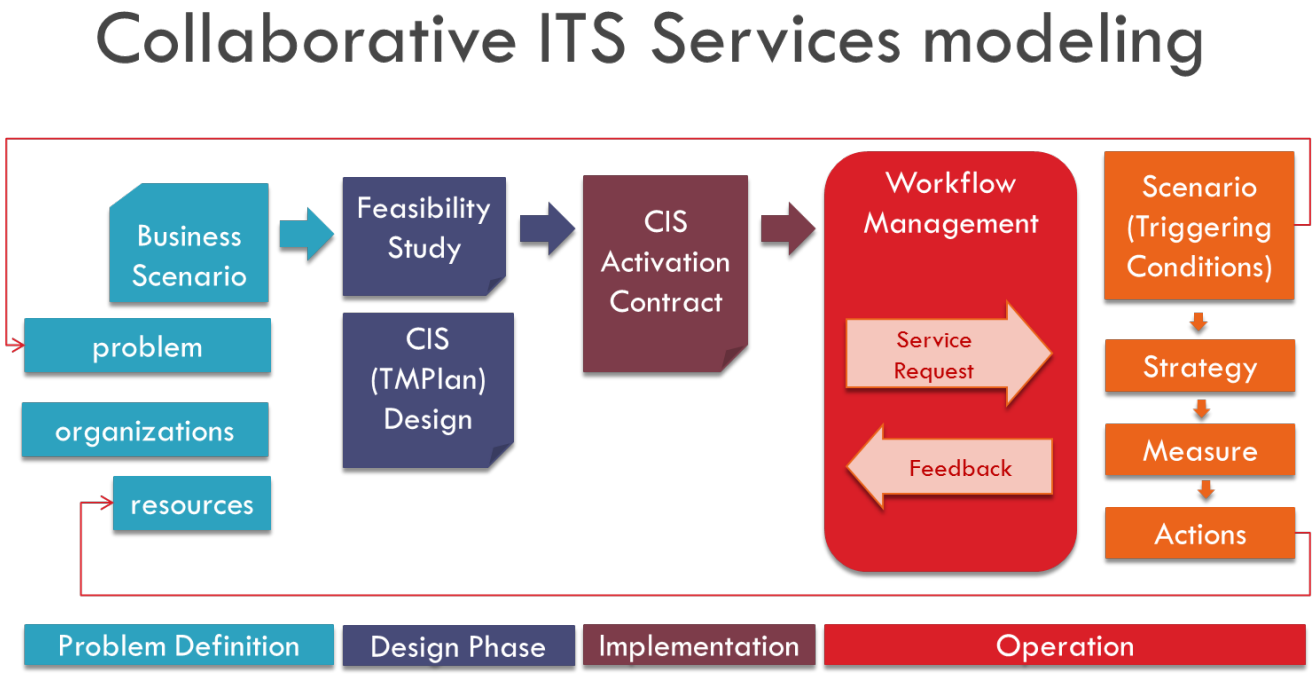


Fig. 5 – CIS (TMPlan) Analysis, Design, Implementation and Operation phases

At real time, Service Request for CIS Implementation will be exchanged, as well as Feedbacks, to set up the predefined needed resources configuration, i.e. Strategy activation and single Actions referred as each resource disposal by an organization.

Extending the TMPlan by CIS Concept we can figure out any resource configuration (VMS, LCS, Cameras, Traffic Lights, etc) as a specific request for Service to be activated by another Centre.

Strategies and relative Actions are concepts defined in Deployment Guidelines, triggering conditions means the road situation or data which requires the need for operating a TMPlan or in a general way a CIS.

During Operation, Request for Services **are usually to be validated by the involved centres operators**, so Standard Operation to implement CIS is based **on 2 phases**: CIS Agreement and CIS Execution, each of them is implemented by a Specific Service Request and the Execution is achieved after Agreement has been done. In case Agreement is not achieved for a known reason, which can and should fed back, the requester should

evaluate how to deal and eventually ask for a different alternative CIS (as shown in Fig) or should evaluate the condition at a higher decisional level.

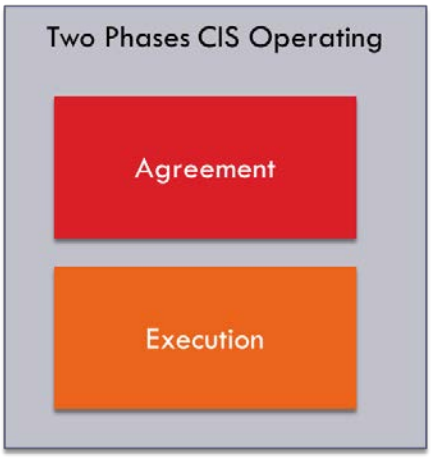


Fig. 6 – two phases CIS operation

In simpler Service Request, such as VMS management for information only purposes, the CIS request may still be valid, even if it will be implemented only by some of the centres involved, and it will itself be operating the same way if any of other centre won't execute such request. In these cases the Agreement phase can be avoided and one phase Execution CIS can be implemented: one of these cases is **VMS setting for Traffic Condition Information**, i.e when there is no need for coordinated management but only information needs, any VMS setting implemented will improve the global service to road user, and no other management is needed in case for instance a VMS cannot represent this information for a fault or for higher priority information displayed on the requested VMS.

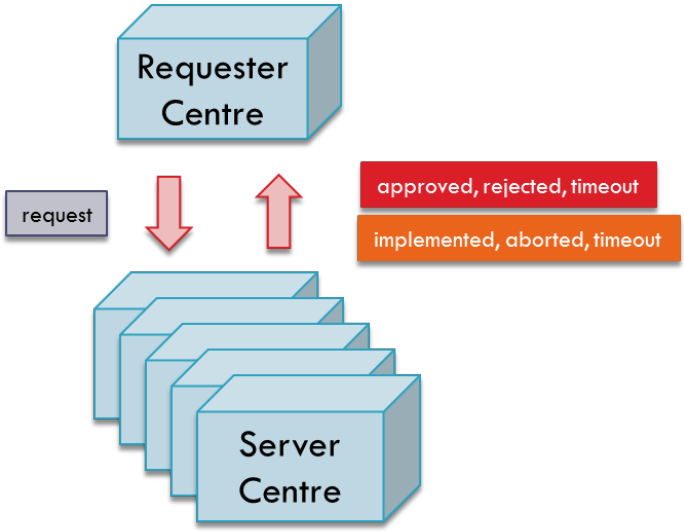


Fig. 7 – CIS implementation workflow among a requester Centre and one to many Implementer Centres

And we can see this in application of this worflow management for Traffic Managament Plan

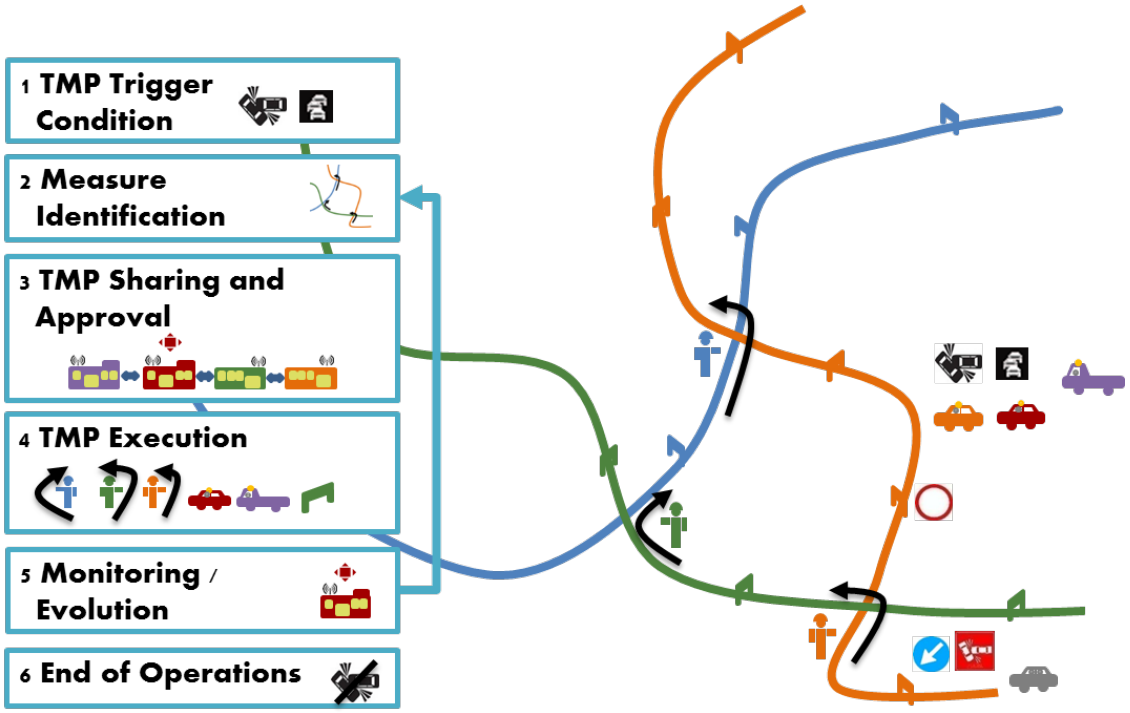


Fig. 8 – TMPlan implementation phase description

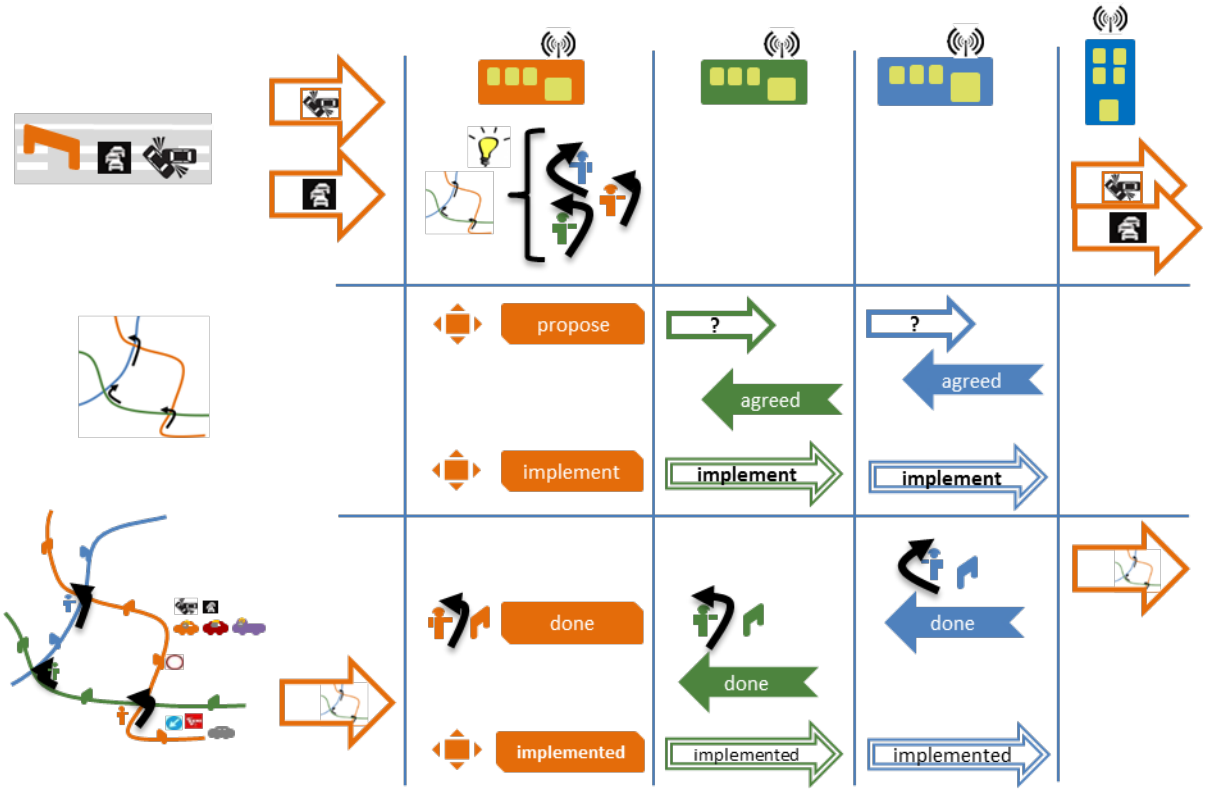


Fig. 9 – Single TMPlan Measure implementation via Agreement and Implementation Phase

CIS Implementation Patterns

As seen in the previous paragraphs Collaborative ITS Services in our vision is the availability, usage and shared management of ITS Services implemented by Centres distributed along the Road Network.

The following figure depicts a set of connected Centres, each of which exposes several services.

These services can be combined to implement CIS (/TMPlan) after the request of a Specific Requester Centre (red)

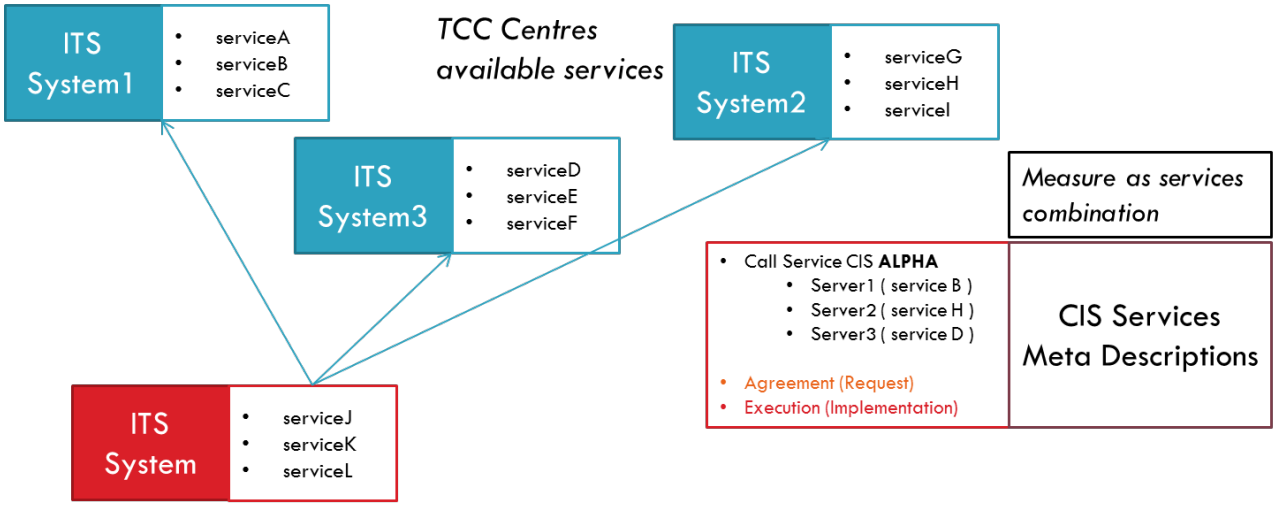


Fig. 8 – CIS as shared distributed services availaibility and usage among Centres

In real life each Service is realised by its own customized interface, using each one proprietary parameters, datatypes, syntactical rules and semanthical definitions. Each TCC ITS System implement many services that could even be accessed from remote to enable other Centres to use them after agreement, for realtime services, using these proprietary legacy interfaces, and even when implemented via standard interfaces as WebServices needs adjustment and agreement among centres to set appropriate parameters defining parameters values and semantics.

In the domain of Centre to Centre exchange, DATEX technology is used to uniform data and give shared syntactical check rules and semantic understanding, as well as common handshaking and behaviour for data exchange patterns and communication errors or network failures management.

Having this framework in mind we can see DATEX CIS as the usage of DATEX nodes as a data exchange interface to convey information to enable and control services, adapting the legacy protocols of individual clients and server legacy systems, and wrapping individual node services: i.e. DATEX nodes acting as gateways which wrap the heterogeneity of the several multi language and national legacy systems enabling interoperability and common strategies achievement.

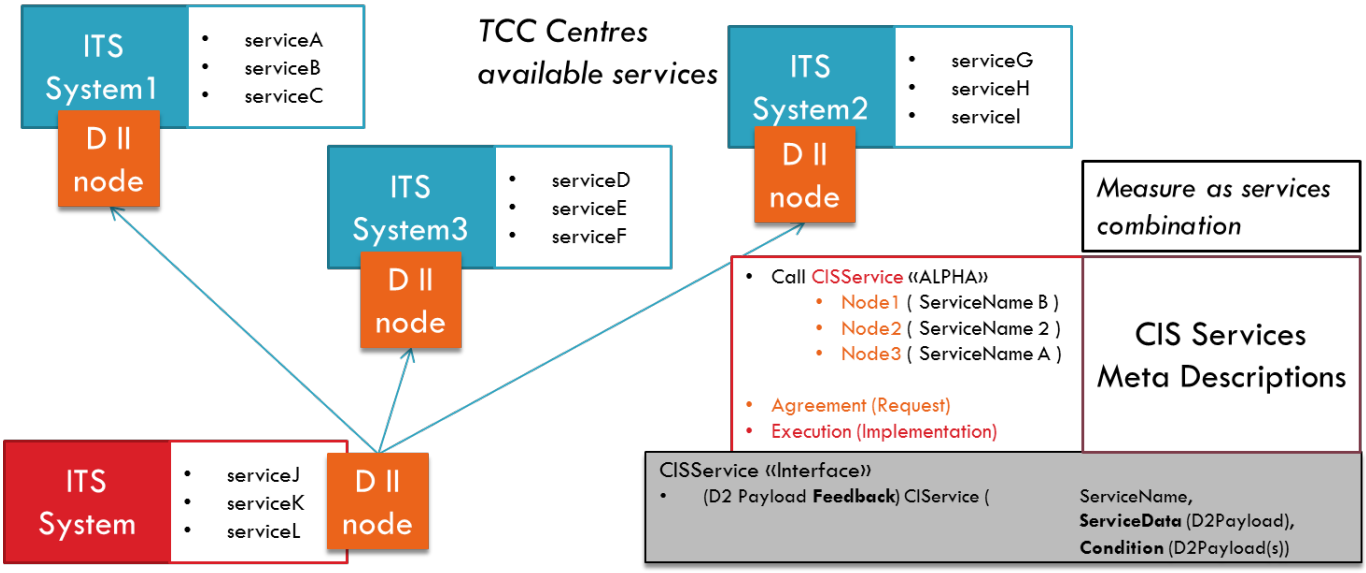


Fig. 9 – CIS by DATEX: nodes act as gateways wrapping individual centre complexity and adapting semantics to a standardized language and interface.

A Service interface may be realised exposing a "common general" Collaborative ITS Service interface through which a Service may be invoked by the node on the actual TCC Server (ITS System) and Payload(s) can be conveyed which will be processed by the invoked Service.

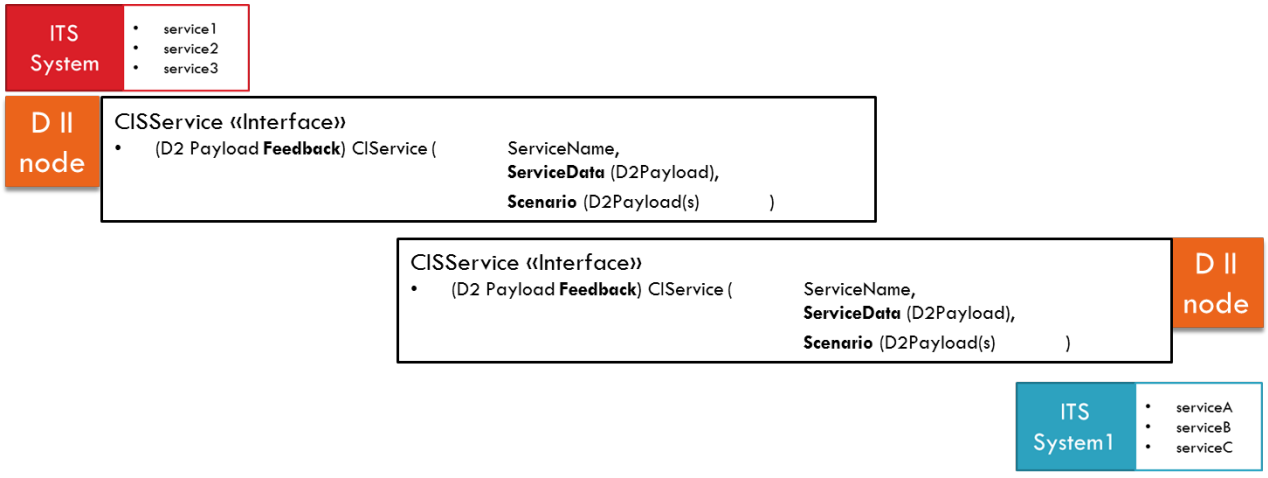


Fig. 10 – CIS by DATEX: implementation though "webservices" call

First option for a service method interface:

CISService «Interface»

- (D2 Payload **Feedback**) CIService (ServiceName, **ServiceData** (D2Payload), **Reference** (D2Payload(s))

That could be used with conventional shared names services like “TMPlanService” or “Feedback”

CISService «Interface»
- (D2 Payload **Feedback**) CIService (**«TMPlanService»,**
  ServiceData (TMPlanPayload),
  R**eference** (Scenario D2Payload(s))

CISService «Interface»
- (D2 Payload **Feedback**) CIService (**«Feedback»,**
  ServiceData (D2Payload Feedback),
  Reference (TMPlanPayload))

Further Option use for Request CIService passing the requested Service name as data in the Request Payload and for Feedback CISFeedback.

CISService «Interface»
- (D2 Payload **Feedback**) **CISFeedback** (**ServiceData** (Feedback),
  Scenario (TMPlanPayload))

It’s evident now that requesting for a Service done via the DATEX node is not directly invoking a Service on that ITS System but abstracting the operation of invoking service and demanding it to the DATEX node, having information or data parameters required for the service adapted by the DATEX node client gateway to the specific service parameters to the specific ITS System.

In this vision invoking a Service through DATEX can also be equivalent as conveying one or more DATEX payloads and invoking specific Services through their “ServiceName” and this means in DATEX II Information Delivery pattern conveying information and data through DATEX nodes. This implies that Information Delivery of Service Request Publication could be used to actually request for services so the same interface and WS Notification can fully be used to convey payloads among DATEX II nodes for new Service Request and Service Scenario DATEX payloads.

Examples:

- Requesting one or more centres to implement VMS Message sending situation record and asking it to be processed to address VMS messages based on predefined rules.
- Requesting one or more centres to implement on some specific VMS specific messages explicitely conveyed through VMS Publication.
- Requesting one or more centres to implement a specific Predefined TMPlan, sending a TMPlan Publication (or a more general CIS thrugh CIS Service request Publication).

On the other way round, there is also the need for the Node Requesting the Service to be informed about the success or failure of the service request, i.e. a Feedback which also is information which can be exchanged by DATEX wrapped in a Feedback Publication.

Again the Feedback may be seen as a return information from the CIService invocation or simply as a payload itself exchanged back from the Node executing the service.

As seen in the first paragraph showing the sequence Diagrams and all actors which need to be considered when a Service is to be implemented on exchange data, to have the overall Feedback of the Service Request implies the whole process to implement the Service is to be completed before receiving such feedback. In this case service invocation can only be synchronous, and some IT resources allocated by the Service Request will be locked while waiting for such process to be completed, and further Agreement phase normally implies human operator to take some manual actions and decisions.

During the service implementing phase some intermediate processing results could be be notified to the Requester, before the overall result would be achieved, giving evidence of progressive processing phase. It could be preferable to feedback soon the request about only syntactical check and receive other intermediate and final feedbacks based on the progressive evolution in the processing phases.

The situation can be expressed by the following figure:

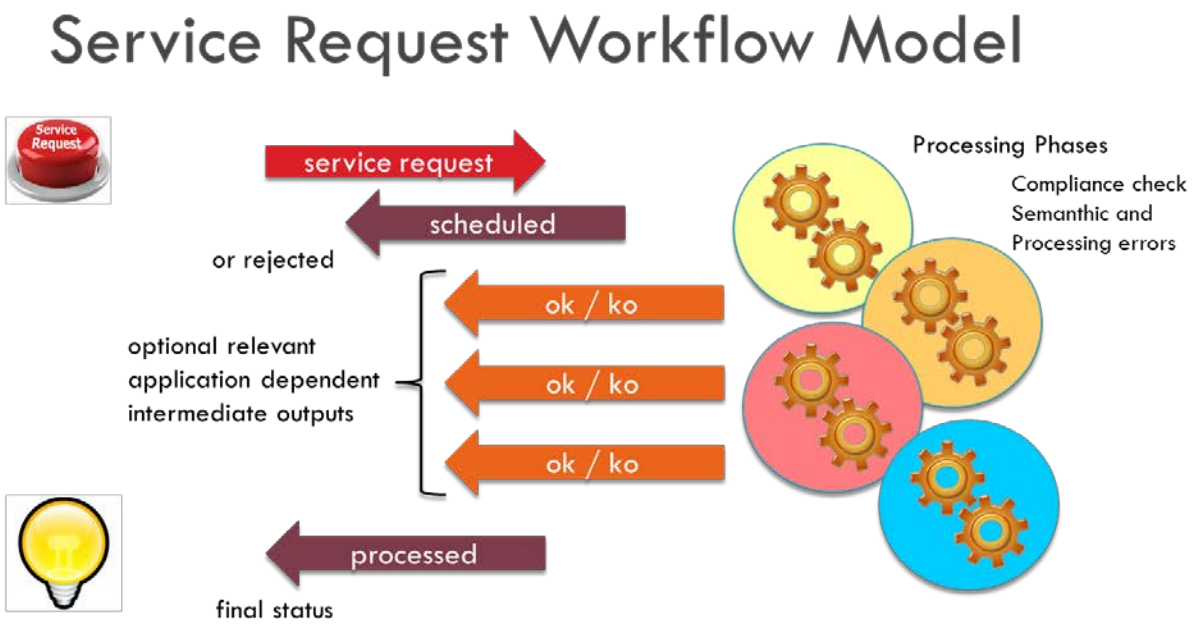


Fig. 11 – intermediate and overall processing feedback in a multi-phase implementation service.

Concurrency Policies

We have to consider a further question prior to think about any implementation / PSM solution to manage Collaborative ITS Services, which is the Concurrency Policies which runs and regulate the business cases.

Whenever we think of a Service as a Resource usage to some objective which is active and shared or notified by a Service Requester to a Service Implementer, we have to think about which kind of resource is this and how can be managed if some other requests gets in concomitancy with the current one which corresponded to the first known one.

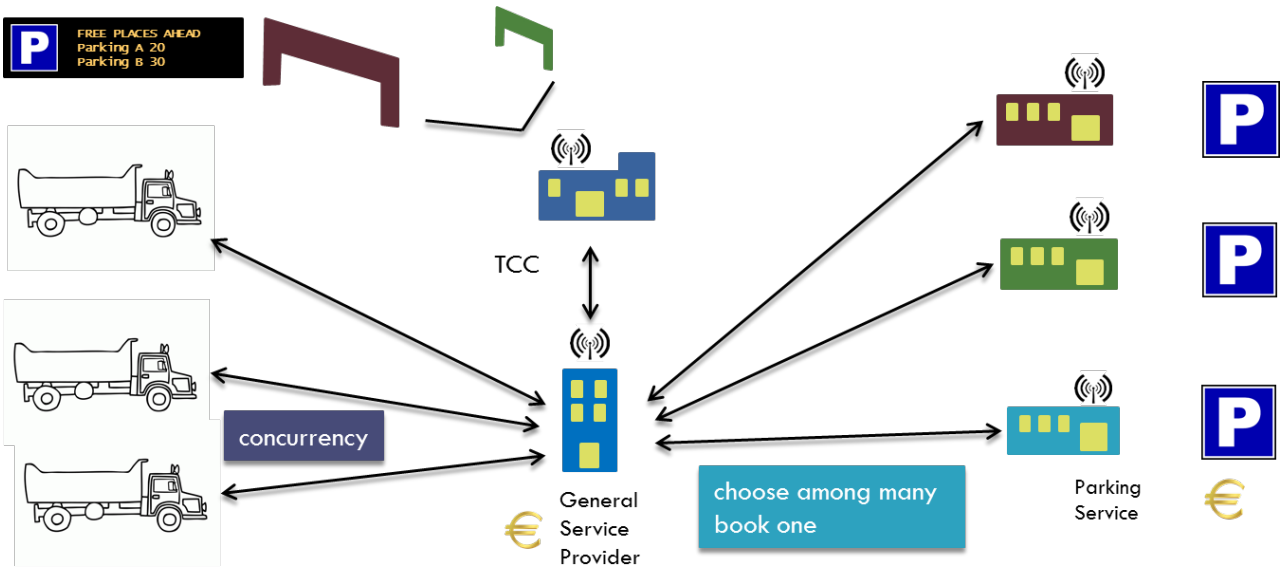
Whenever we have the need to allocate the same resource to different usage and use cases we have to consider concurrency policies which are to be observed. There are two main cases we consider:

- **First Come - First Served FIFO Police**

Request for Services may be considered as they come, and there is a implicit lock of Resources for Booking, the resource is granted to the first request received..

As an example we consider Car or Truck Parks booking in specific Parking Area, such as the case of Secure Parking Area for HGV. It implies guaranties for booked resource and Payment of fee to book which is lost or partially refunded if resource will not be used. Also there may be policies to release resources after a timeout period in case they will be not used and resource release will be allowed with partial or total refund within a certain amount of time.

In the figure below the use case is depicted which may be granted by a Booking and Payment Service provider which manages communication to Parking Service Providers implementing locking and releasing of resources after payment guarantee.



- **Conditional Priority**

Either when we think of Services as VMS displaying information Messages about Road Situatons or Traffic Management Plans the rule to manage priority is totally different as a new situation may arise which is much more relevant to be displayed on VMS, or to be managed by TCC with a different Network Operation set leading to a completely different Scenario and TMP Management.

We call this Conditional Priority Policy when more Service Request could be received subsequently but a more recent one may have higher urgency, so that a First Request could be Rejected or Cancellation/Termination Requested after first Approval and the higher Impact TMP request due a more impacting situation should be served.

Depending on Concurrency Policy

- **First Come First Served**: distribute transactions protocols are needed to ensure consistency and avoid conflicts. The field of application is related to payment and booking of resources which will be allocated and could be released under precise conditions such as:
    a. **Parking Facilities**
    b. **Tunnel Slot Booking**
    c. **Alternative Path allocation per vehicle, for Dynamic Rerouting**
    d. **Special Path prescription / Specific Itinerary for HVG or Exceptional Load**

- **Conditional Priority**: several decision level could be implied, as wel as Operator Decision based on rules or Decision Support System could be needed to evaluate priority and solve conflicts. In some cases conflicts could be managed at higher decisional hierarchy level. As a requirement need for Exchange there is a need to Manage Workflows enabling decision making and resume

CIS PIM / PSM Implementation Patterns

Based on current DATEX II achievements and after the previously reported consideration we may consider that we have several choices for the Service Request and Feedback Implementation.

- ☐ **1 - Fully Based on Information Delivery**
  - ◘ CI Service Request Publication Notified to CIS involved partner by Requester node
  - ◘ Feedback Publication Notified to Service Requester by CIS involved Partners

  This pattern implies 2 one-way communication that could be based on current DATEX delivery
    - ☐ Agreement, when needed, and Execution delivered from CIS Requester to implied nodes
    - ☐ Feedback, other way round, from implied nodes to CIS Requester

This implementation of CIS Exchange can be implemented in currently available DATEX II exchange platform base on modelling Service Requests and Feedbak information as DATEX II payload extending current 2.3 model by a level B extension.

In future when new Exchange specification will be available DATEX II Service Requests and Feedback may be implemented by appropriated web services or other technology.

We just make some example of different patterns which could become available based on alternative exchange platforms.

- ☐ **2 – Based on Service Request with synchronous Answer**
  - ◘ only 1 definitive answer: RequestedServiceProcessed o requestedServiceAborted/Rejected
  - ◘ CISServiceRequest invoked from Coordinator Node
  - ◘ Synchronous CISFeedback Response

  In this vision there is only 1 one way Service Request, a new PIM interface should be developed at echange level.

- ☐ **3 – Bilateral Service Request (or WS Notification Hybrid)**

  Multiple progressive Feedback about the status of Service Request execution
  - ◘ CIS Request Service
    - ☐ E.g. uploading TMPlan Request and Scenario Payloads for triggering conditions
  - ◘ CIS Feedback Service
    - ☐ Immediate feedback on Service Requested received and Scheduled

- ☐ Multiple progressive Feedback about the status of Service Request execution

  i.e. Asynchronous Service Request Response, implemented as «CISFeedback» Service (or WS-Notification for Hybrid solution

About requirements for Locking and Releasing of resources as described in FIFO Policy concurrency business case, the work to be done needs more refinement and a better business case knowledge is needed to correctly evaluate and define the needs for designing a specific implementation. There have been done some preliminary investigation analysis, looking for similar Shared Service usage we had also found similar options embedded in other standards to be further analysed.

- ☐ **4 – Implementation based on WS-Coordination and WS-Atomic Transaction specifications**
  - ◘ Pros .. Available base specification, available java implementations
  - ◘ Cons.. complex, to be studied, maybe too much as there are not only IT Resources involved in the business scenario
  - ◘ Maybe could be used for booking resources for Parking facilities Booking .. Any stakeholder available at present in TG to support this requirements ?

The choice of the pattern which fulfils each specific requirements, with a combined implementation platform (such as RESTful service, Websocket, SOAP) will lead to the design of the consequent FEP/PSM for the Use Case Collaborative ITS Services, to be fully specified in the future work.

CIS and TMPlan model Extension

Extension Model for CIS and TMPlan Management Rationale

The provided TMPlan extension model contains 2 **extended Publication** packages for

- **Collaborative ITS Service Request and Feedback Extension: CISExtension**
  - Used to convey information about Collaborative ITS Service Request and relative feedback.
- **Traffic Managament Plan Extension: TMPlanExtension**
  - Which model the information needed to describe predefined TMPlans and TMPlan Activation.

Implemented on the base of DATEX II version 2.3 and Data Delivery Exchange Pattern, as mentioned in previous chapter last paragraph: CIS PIM / PSM Implementation Patterns, pattern 1 - Fully Based on Information Delivery.

IMPORTANTE NOTICE

According to DATEX II paradigm based on separation of concerns among Road Traffic Data Information and Exchange related Information, we specify that information managed in the CIS Model extension as Service Request and Service Feedback Publication are “Exchange related” Information which are needed to implement Collaborative ITS Services, based on current Information Delivery oriented Exchange Platforms PIM and PSM.

Those information are not to be considered Road Traffic Data Payload Publication, which is the only appropriate domain for DATEX CEN TS-16157, but these Publication are the only available hook to exchange information needed to deliver Collaborative ITS Services Information base on Information Delivery based Exchange PIM/PSM.

In future DATEX II releases those information will not be modelled as payload information on CEN TS-16157, which is dedicated to model only Road Traffic Data as Payload Information. Instead future available specification for DATEX II Exchange ,which are to be standardised by ISO TC204/WG9 and CEN TC278/WG8, will model and give specification to adequately implement Collaborative ITS Service in a Exchange PIM/PSM supporting both Information Delivery and Collaborative ITS Services.

CIS Extension Model implementing CIS Exchange and Workflow

General concepts

As fully described in First part of this document the implementation of Collaborative ITS Services may be reduced to the Information Delivery Use case of Service Request Information from a Requester Centre to the Service Implementer Centre which on the other part will need to deliver back a Service Feedback Information from the Service Implementer Centre to the Requester.

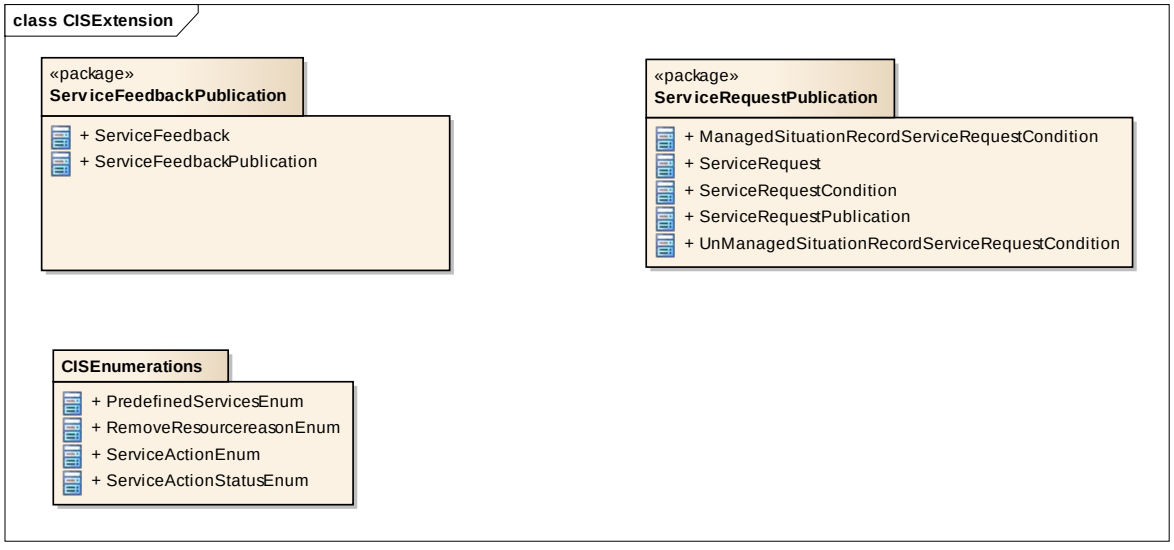
According to this model a Collaborative ITS Service may be seen as application processing of Information which are have been delivered in a previous Delivery and are referenced in the Service Request.

The current Extended Model contains 2 Extension packages

- CIS Extension
- TMPlan Extension

Package CIS Extension include ServiceRequest Publication and Service Feedback Publication Models and related Enumeration which are explained in this chapter.

As explained in the previous Chapter CIS Extension Publication are dedicated to model information that is related to Service Requests and Service Feedback management which are not to be considered as Road Traffic Information so they would not be modelled as Payload Information based on DATEX II modelling rules, but will be modelled in the future in the versions of PIM and PSM Exchange Specification which will be delivered in the next period

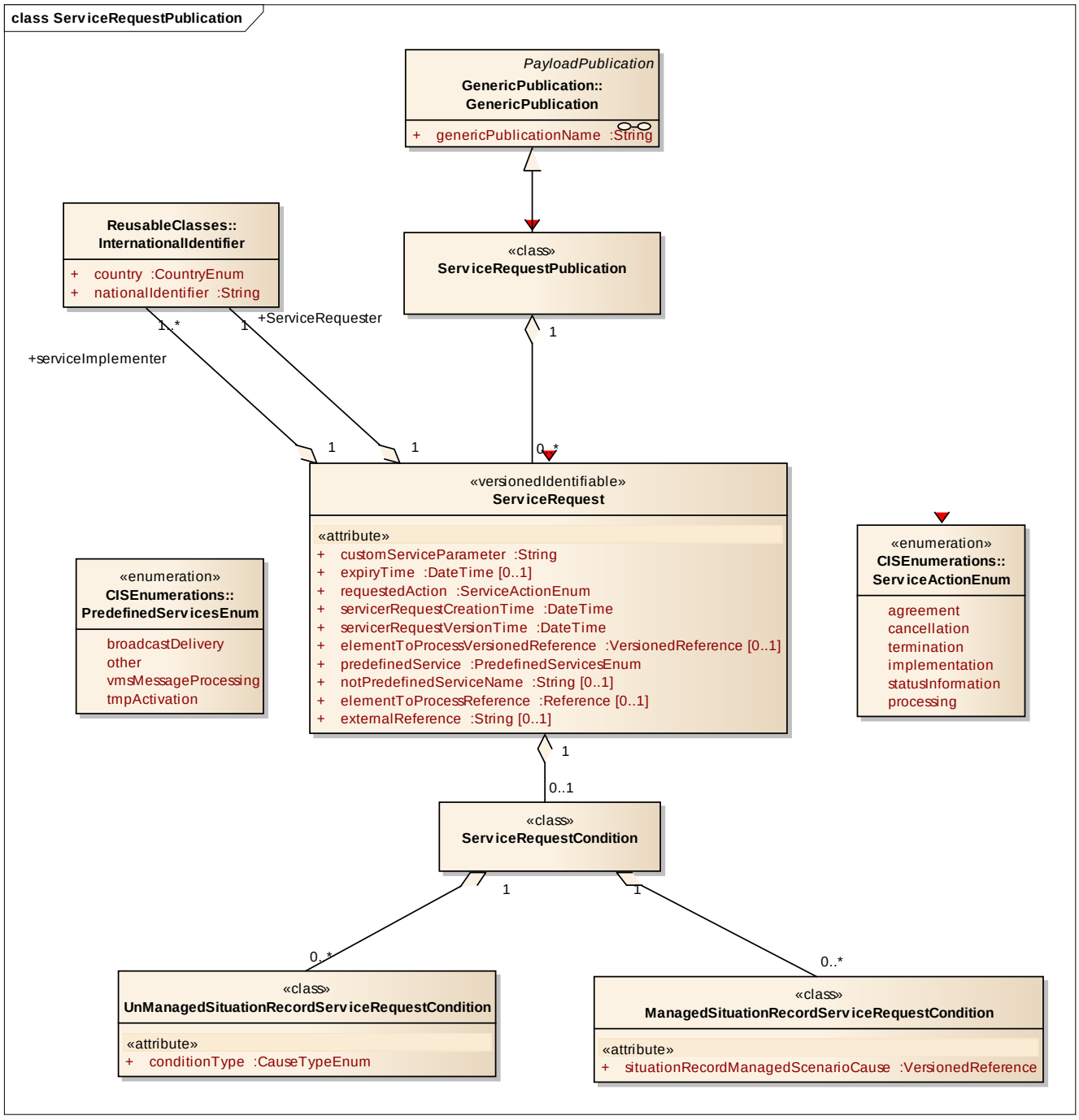


Instead TMPlan Extension will include all concepts which are fully considered Road Traffic Data used to describe and rule Traffic Management Operation which is considered as Traffic Management Plan Information.

Service Request Publication

Classes Diagram

With the only reference to Collaborative ITS Service Request requirements, i.e. application processing of previous exchanged information, the classes needed to model delivering Service or application processing request are contained in ServiceRequestPublication Package and are in the following schema



Classes

ServiceRequestPublication: A publication used to convey information for CI Service Reques, i.e. specific processing instructions on exchanged information.

ServiceRequest: identifies the request for a specific Service, i.e. processing on exchanged information, to be activated

Contains as attributes

> ***predefinedService***: predefined service type: from PredefinedServicesEnum, such as broadcastdelivery, vmsMessageProcessing, tmpActivation used for TMP Activation workflow, other
>
> ***notPredefinedServiceName***: Name of service request, mandatory in case the Service Request is not of a specific predefined Type or other
>
> ***requestedAction:*** identifies the action requested for the specified Service, as agreement, implementation, cancellation, termination, information on current Status..
>
> ***elementToBeProcessedReference***: the Reference to a specific exchanged Information to be processed which is represented by an Identifiable Class.
>
> **elementToBeProcessedVersionedReference**: the Reference to a specific exchanged Information to be processed which is represented by an Identifiable Class
>
> **externalReference**: any reference to information to be processed which is not describe as Identifiable or Versioned Identifiable classes in DATEX model.

Contains as attributes the reference to information to be processed

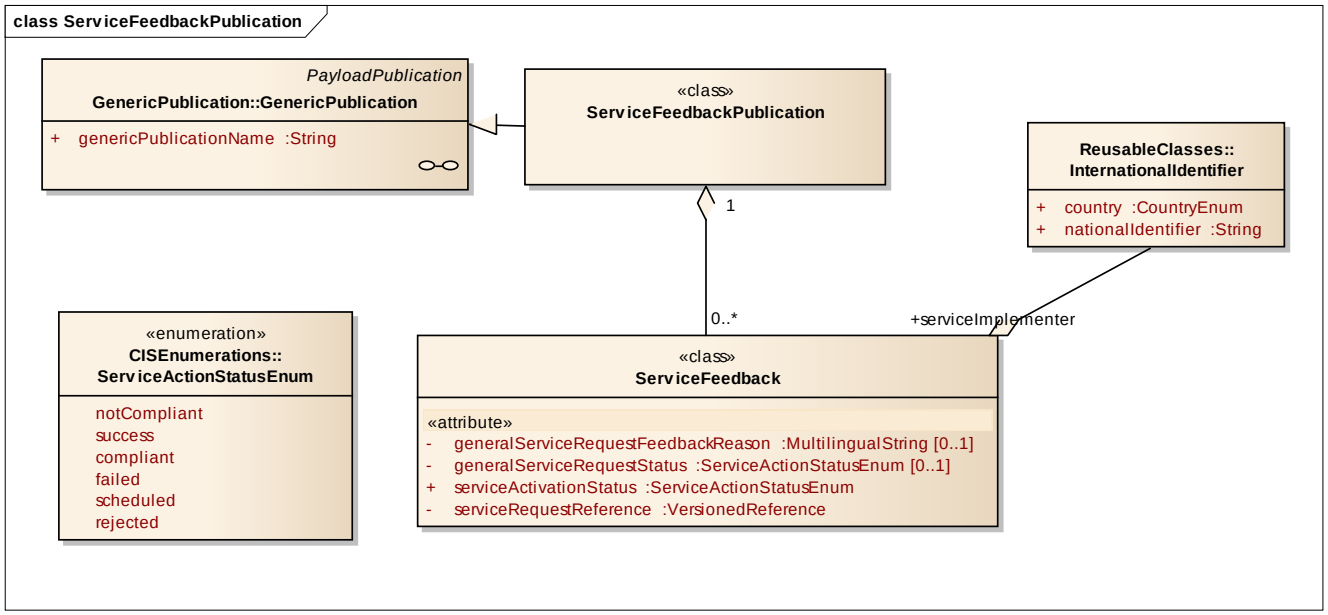
ServiceRequestCondition: Information about any Situation or Conditions on the road networks that leads road operators to initiate a Service Request, normally used for Tmp Activation Service.

It is an optional information which mostly had been implemented for use in case of TMP Request but can be used in general Service Request: it gives the link to:

> **UnManagedSituationRecordServiceRequestCondition**: Reference to a Unmanaged Situation which is part of the Service Request Condition
>
> or
>
> **ManagedSituationRecordServiceRequestCondition**: reference to a Situation Record which is part of the Service Request Condition.

Feedback Publication

Classes Diagram



ServiceFeedbackPublication package models feedback information about a previously requested Service.

Classes

It contains following classes

ServiceFeedbackPublication: Publication used to convey feedback on data exchange status for processing status of previously exchanged information

ServiceFeedback: Feedback about a specific Service Request from the Service Implementer to the Requester

With attributes

> ***serviceActivationStatus***: the current Activation Status of the Service having being requested
>
> ***serviceRequestReference***: Reference to the service request to which refers the Service Feedback
>
> ***generalServiceRequestFeedbackReason***: additional text to feedback about the Status of the Service Request
>
> ***generalServiceRequestStatus***: specifies the Status of Service request referenced

CIS Service Request and Feedack Workflow Description

Coordinator Node as Service requester

In the CIS (TMPlan) pattern we introduce the concept of Coordinator Node.

The center that recognize the need to implement a CIS (or TMPlan) is called the Coordinator node and will be responsible for publishing the proposed CIS Request to the interconnected nodes that must approve the proposed ITS Service and then implement them.

It is expected the rejection of the proposal for an adequate reason.

Receiving, understanding and then accepting and rejecting of proposals are sent back by the nodes involved in the exchange to the Coordinator node, through the Service Feedback Publication that will contain a reference to the CIS Request (or TMPlan Activation) exchanged in a previous Service Request Publication.

In case of refusal or inability (rejection / failure) to implement Services (or TMPlan measures and actions), the control will go back to the Coordinator node which will be in charge of managing the updated scenario and operating conditions, asking for different strategies or measures or giving the control to another node.

Workflow

In this section the various exchanges of information and messages aimed decisions about activating TMP are explained.

Sequence diagrams are shown based on different workflow results (success, failure, rejection, timeout) for any Action which is requested in a Service Request workflow.

In case of refusal or unavailability of resources to implement the requested Service, the control will go back to the Coordinator node which will be in charge of managing the updated scenario and operating conditions, asking for new CIS to be implemented or another node to begin a new Service Request as Coordinator.

NOTE. Normally a higher strategic level node is expected to manage lack of resources or any discrepancy on traffic management rules which may arise among conflicting objectives pursued by different TCCs, this strategic management level will be run offline and is not out of scope in this model.

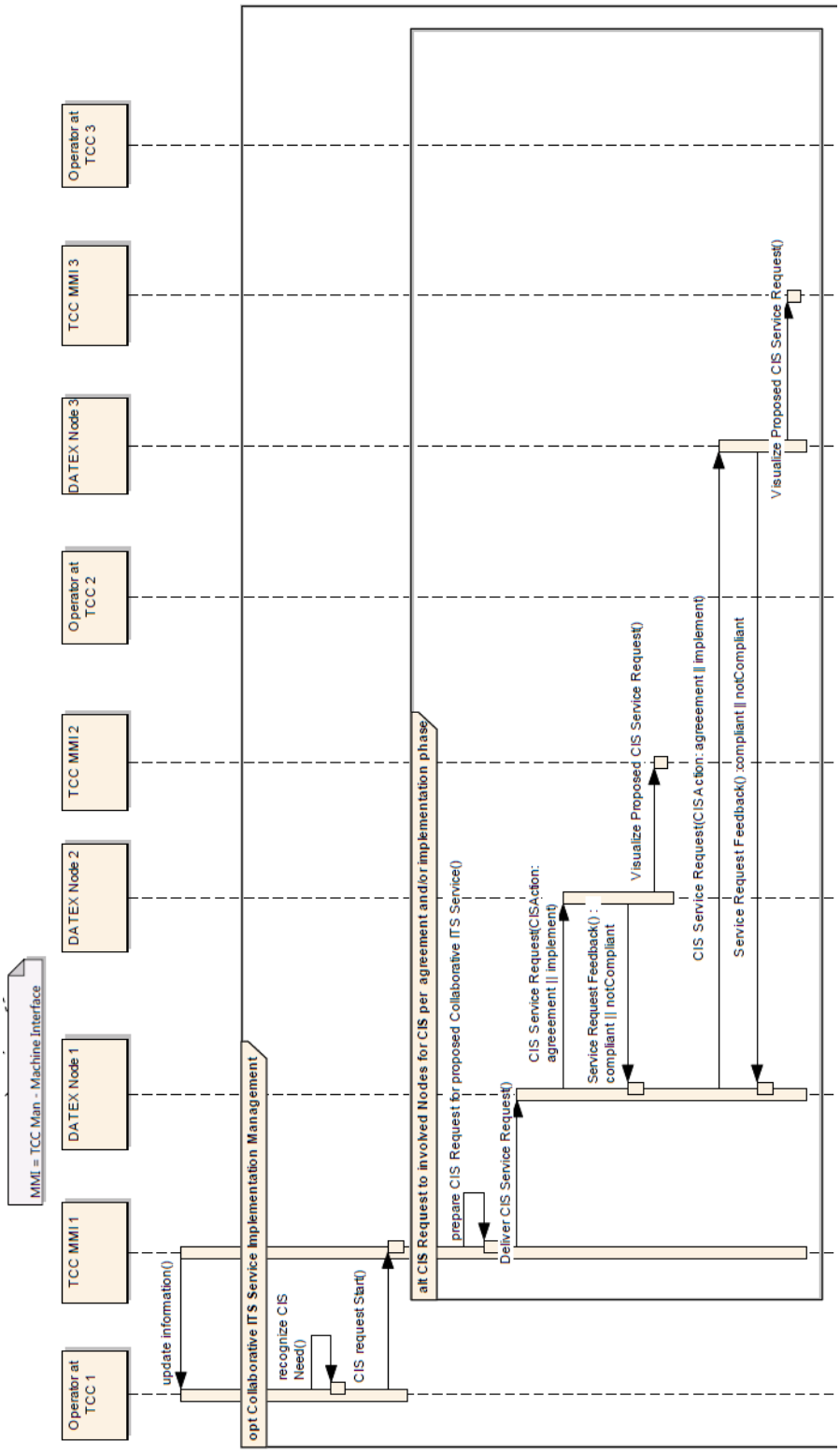
In these sequence diagram not only the transmission systems (i.e. DATEX nodes) are relevant, but the system which operated by TCC operators and TCC operators itselves are important to identify precisely the exchange and decision workflow.

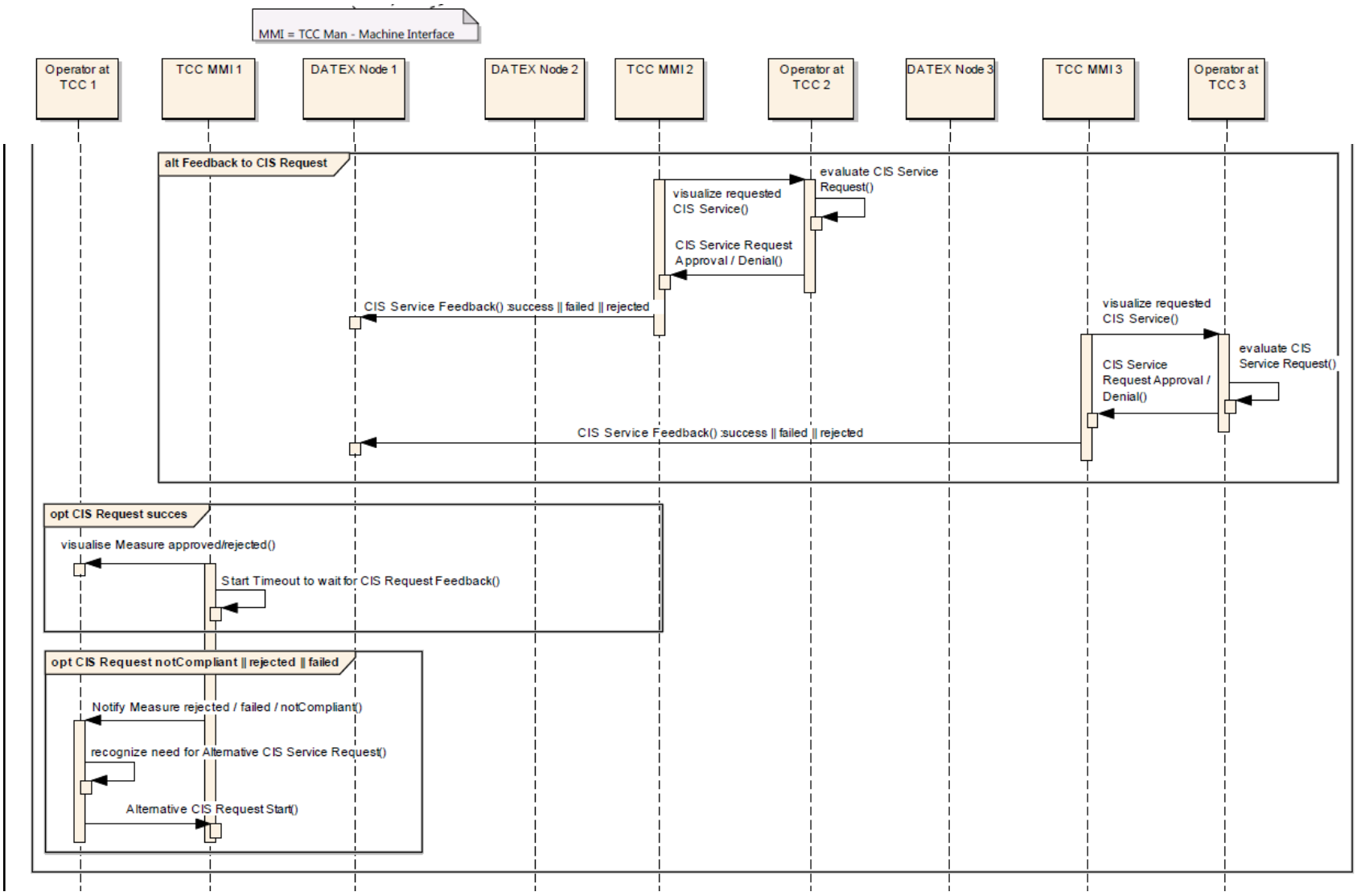
CIS Request and Feedback Workflow Steps

- The Coordinator raise e CIS Request to all nodes which are needed to implement a CIS (1 to many as needed)
- Feedback on Service Request compliance and processing of Service Request are collected (Service Request could be based on a Agreement and Implement 2 phase request or on only on Implementation request)
    - In a 2 phase model Agreed Service Request are to be implemented from all cooperating centres / Road Operators and Authorities. Both Agreement and Implementation Feedback are collected by the Coordinator Node.
- Each node is to feedback the Coordinator node about approval or rejection of Service Request.
    - Feedback are to be delivered within a timeout which had been agreed by all the Operators.
- Feedback results are available through TCC system to operators for any further decision on Operation.
- After compliant Service Request delivery a timeout is started to wait for processing feedback, delivery of success, failure of rejection due to any reason are to be notified from all collaborating nodes via Feedback Publication
- In case of failure or rejection of Service Request notified to the coordinator node, an operator has to consider this and take the updated Scenario into account to understand how to manage further or switch control to another node (normally with higher hierarchy level)

After this step as there will be any evolution of Condition and any need for further Measure implementation arise, a new Scenario will be recognized and the consequent Overall Measure will be claimed. This Further TMP evolution can be managed by the same Coordinator which initiated the previous one, or by any other nodes in the DATEX II Network cooperating for TMP Management.

Sequence Diagrams for Worflow Service Request and Feedback management




MMI = TCC Man - Machine Interface
Operator at TCC 1
TCC MMI 1
DATEX Node 1
DATEX Node 2
TCC MMI 2
Operator at TCC 2
DATEX Node 3
TCC MMI 3
Operator at TCC 3
alt Feedback to CIS Request
evaluate CIS Service Request()
visualize requested CIS Service()
CIS Service Request Approval / Denial()
CIS Service Feedback() :success || failed || rejected
visualize requested CIS Service()
evaluate CIS Service Request()
CIS Service Request Approval / Denial()
CIS Service Feedback() :success || failed || rejected
opt CIS Request succes
visualise Measure approved/rejected()
Start Timeout to wait for CIS Request Feedback()
opt CIS Request notCompliant || rejected || failed
Notify Measure rejected / failed / notCompliant()
recognize need for Alternative CIS Service Request()
Alternative CIS Request Start()

TMPlan Model Extension

General Concepts

As mentioned in Background a best guide for Traffic Management Plan (TMPlan) concepts is contained in Easyway Deployment Guidelines in TMSpackage2012 Traffic Management Services - TRAFFIC MANAGEMENT PLAN FOR CORRIDORS AND NETWORKS Deployment Guideline (TMS-DG07 | VERSION 02-00-00 | DECEMBER 2012) (download at http://dg.its-platform.eu/DGs2012)

As expressed also in the beginning chapters we can consider a TMPlan as the implementation of a set of activities that are necessary for the reduction or elimination of traffic disruption or bad level of service at a specific location in the road network as result of high impact incidents or conditions.

The TMP measures are predefined, built up by operators and road authorities in several stages of study and decision-making, taking into account the existing infrastructure, the availability of resources that can operate on the network, the operating devices and technology available at locations in order to implement the necessary measures.

But there are some differences in use and definition of the TMP that emerged from the various working groups, in particular the aform mentioned joint "DATEX and TMP" (refer to Background) working groups has developed in the years 2009-2012 a model for a DATEX II exchange aimed at the implementation of TMP against road situations in the context of transactions between Spain, France and the Basque Country.

Because of these different definitions, in the following the correlation between a defined incident and the set of measures is named “scenario / strategy”.

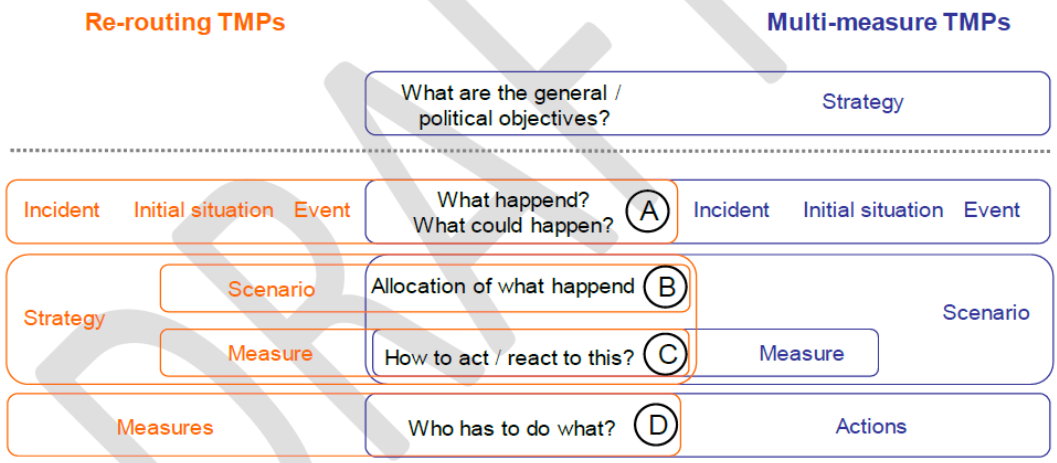


Figure 17: Wordings of TMP typology in Europe

As we can see in fig 1 TMP Deployment Guidelines show two different visions about Measure, Scenario, Action that are interpreted differently in ES-FR TMPlan managemnet compared to the use of these terms in the Nordic countries, as NL, DE. Those discrepancies have been addressed and tried to be harmonized in the current model.

In the corrent document and Model we defines following concepts

TMPlan Activation: a set of TMPlan agreement and implementing request followed by decisions taken by TCC operators, implementation, updates and termination steps of agreed or requested measures and actions, due to some conditions that are active on road network

The TMP Activation starts the first time a triggering Scenario condition is recognized that leads to need for TMP management. Based on evolving situation, TMPlan implementing Measures may be terminated or switched to other Measures (eg a simple closure could become a mandatory rerouting, , and then turn into advisory rerouting with the partial reopening of lanes).

Scenario Condition: the overall situation on the road networks that leads road operators to initiate and run a TMP.

These are the triggering condition for raising a TMP Activation with the request of specific predefined TMPlan Strategy or Measures/ Actions, as well as further conditions that could lead to end implemented Measures and eventually require for new not predefined Measures and Actions to be implemented.

Strategy: an global vision of Measures or operator Actions which are aiming to obtain specific behaviour of the road network, such as closures with alternative itinerary, restriction for HGV, etc

A Strategy is defined by optional specific Measures implemented by each individual elementary operations.

This Strategy have been introduced to handle in one scenario, the TMP-derived ES-FR for snow in the Pyrenees and the Nordic management that seems to have no interest in the detail of Action implementing Measure in the exchange of specific requests.

By Strategy level you can address the overall need for road configuration (e.g. "A4 motorway to be closed from Novara to Torino") which must be activated by alternative Measures and/or combination of Actions by the various organizations / operators and authorities taking part in the overall management to implement the Strategy.

For example: A Strategy could be "to reduce the direct flow from Amsterdam to Utrecht by network configuration management". Those result can be implemented by "reduced lane on Amsterdam ring road " or "rerouting operation out of Amsterdam" with the same reduction in the influx of Amsterdam ring road. This options allows the operator of the center of Amsterdam, which receives the request from the Center of Utrecht, to manage the request at best depending on traffic condition and time of day, rather than indicating specific action / measures.

Measure: a specific set of one or more operator actions which are leading to a particolar network operating configuration such as closures with alternative itinerary, restriction for HGV, etc.

Introduced for convenience for those TMPlan Operating Centers which requires each single operation to be detailed, instead to address a more generic Strategy.

Action: A single operator actions which is part of a TMPlan Measure, which is normally implemented as an Operator Action Situation Record, implementation of specific messages on VMS, Information Delivering

An "Action" is a minimal operation i.e. a necessary single elementary constituent of a given measure. It is uniquely identified and fixed at the time of definition of the TMP.

The proposed model allows then a smooth management of road conditions that may evolve from one condition to another one but also allows to request for a single specific operation to be implemented in a measure, pausing or terminating a previous one, letting the management to evolve from one measure to another one smoothly. This thus skips some lack of flexibility of former proposed model (see Background):

- introducing a condition for the recognition of fixed scenarios as a necessary condition for the initiation of one management measures
- to move to new measures needed by new upcoming scenarios but it did not allow a smooth evolution from different scenario conditions to the implementation of new measures.

Extension Description

Current TMP Extension include 3 packages

TMP Activation Publication

After CIS Framework implementation this publication allows to raise Service Request to agree and implement a specific TMPlan. Requested TMPlan may be predefined or not predefined.

TMP Table Publication

In case a Predefined Strategy or Measure for TMPlan is requested to be implemented, they have to be uniquely identified by a TMPreference ID allowing to uniquely identify those Strategy or Measures . Those reference to uniquely define TMPlan Strategies, Measures as well as single Actions are to be defined previously and exchanged offline such as in TMPlan Design phases. One option is given to exchange those information by DATEX via a TMP Table publication which allows to describe the relevant information by DATEX.

TMP Situation Record

As Operator action are implemented after a TMP Activation Request, the specific Strategy, Measure or Action by which the situation record has been created is referenced by a specific information modelled by Situation Record extended Class.

Feedback in TMP management

An important role in the TMP is played by Feedback and this is managed by ServiceFeedback as documented in CIS Extension model

Service Feedback Publication allows the cooperating nodes to deliver a feedback about the requested Strategy to be returned to the node that asks for the activation of these measures. The feedback processing involve the assessment and decision on the part of the Receiver Node TCC Operators to evaluate the Scenario and check for availability of resources to support the request for implementing the Strategy.

The Center that recognize the need to implement a TMP is assumed as Coordinator node and will be responsible for delivering the proposed TMP Activation Publication to the interconnected nodes.

In case there is a need for 2 phases the Coordinator will raise agreement request and implementation request after agreement. Otherwise simple implementation request will be raised.

It is expected the rejection of the proposal for an adequate reason.

Receiving, understanding and then accepting and rejecting of proposals are sent back by the nodes involved in the exchange to the Coordinator node, through the Service Feedback Publication that will contain a reference to the TMP Activation ID exchanged in the Request.

In case of refusal or failure to implement measures and actions, the control will go back to the Coordinator node which will be in charge of managing the updated scenario and operating conditions, asking for new Strategies or giving the control to another node.

The Strategy will be approved if each node return positive feedback approving the proposal, it will be rejected if one of the nodes reject it.

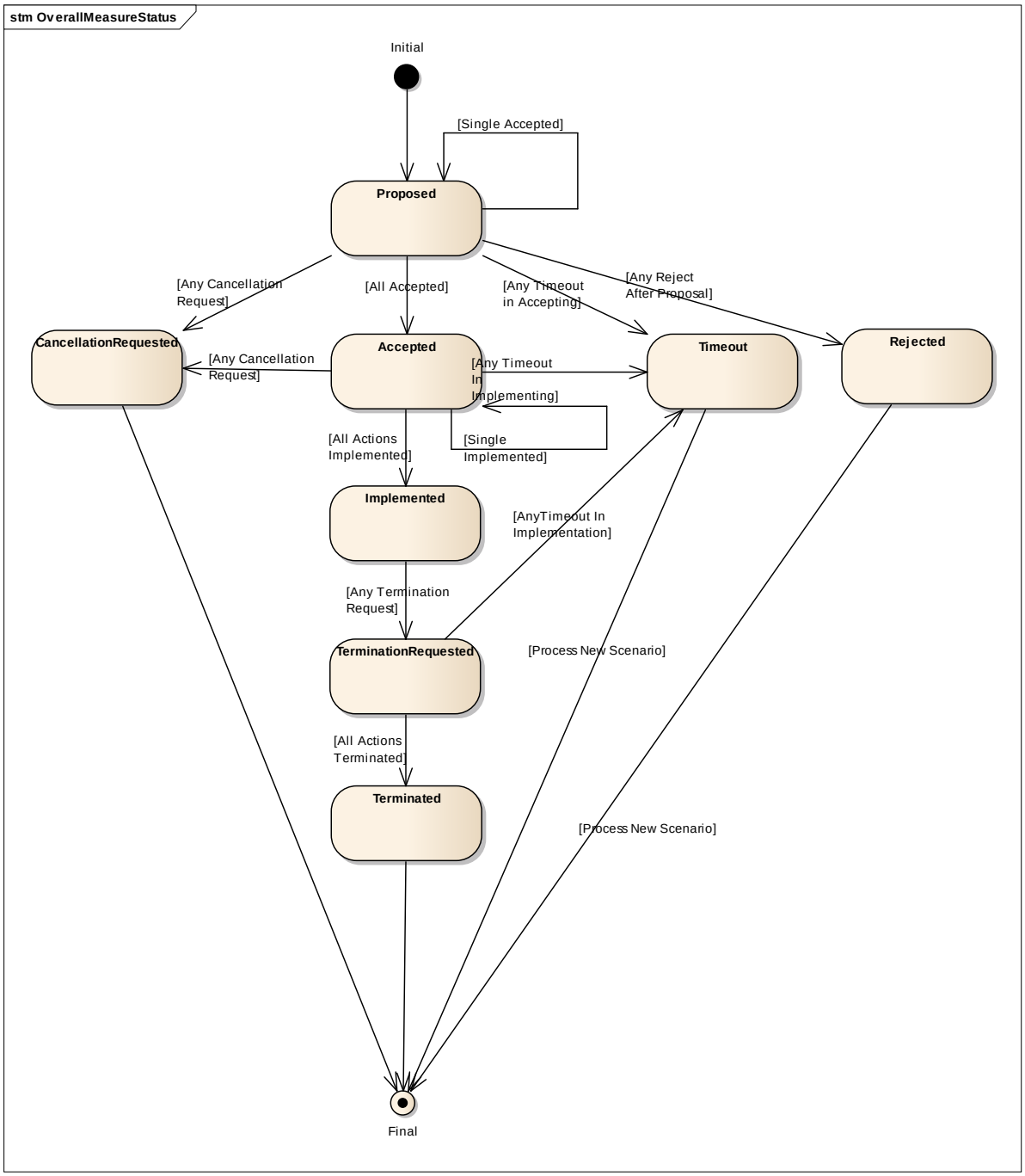
Once the proposal have been accepted, the Strategy is considered to be implemented when all the involved Centres will have implemented the corresponding actions necessary to implement the Strategy Measures on their site.

In case the actions are not implemented, or after a timeout occurs after the proposal approval by all nodes, there will be a need for further analyse and evaluate the overall Situation by the Coordinator operators, in case of a lack or partial implementation of the measure, so they can update TMPlan Activation for new Strategies to be implemented.

TMPlan Activation phase: TMPlan Status information

TMP publication, as explained in the previous paragraphs, allows to send the Centres which are needed to implement a TMP Overall Measure in a coordinated way, the information about this request based on condition that are on/by the road network

Overall Measure State diagram is as follows:

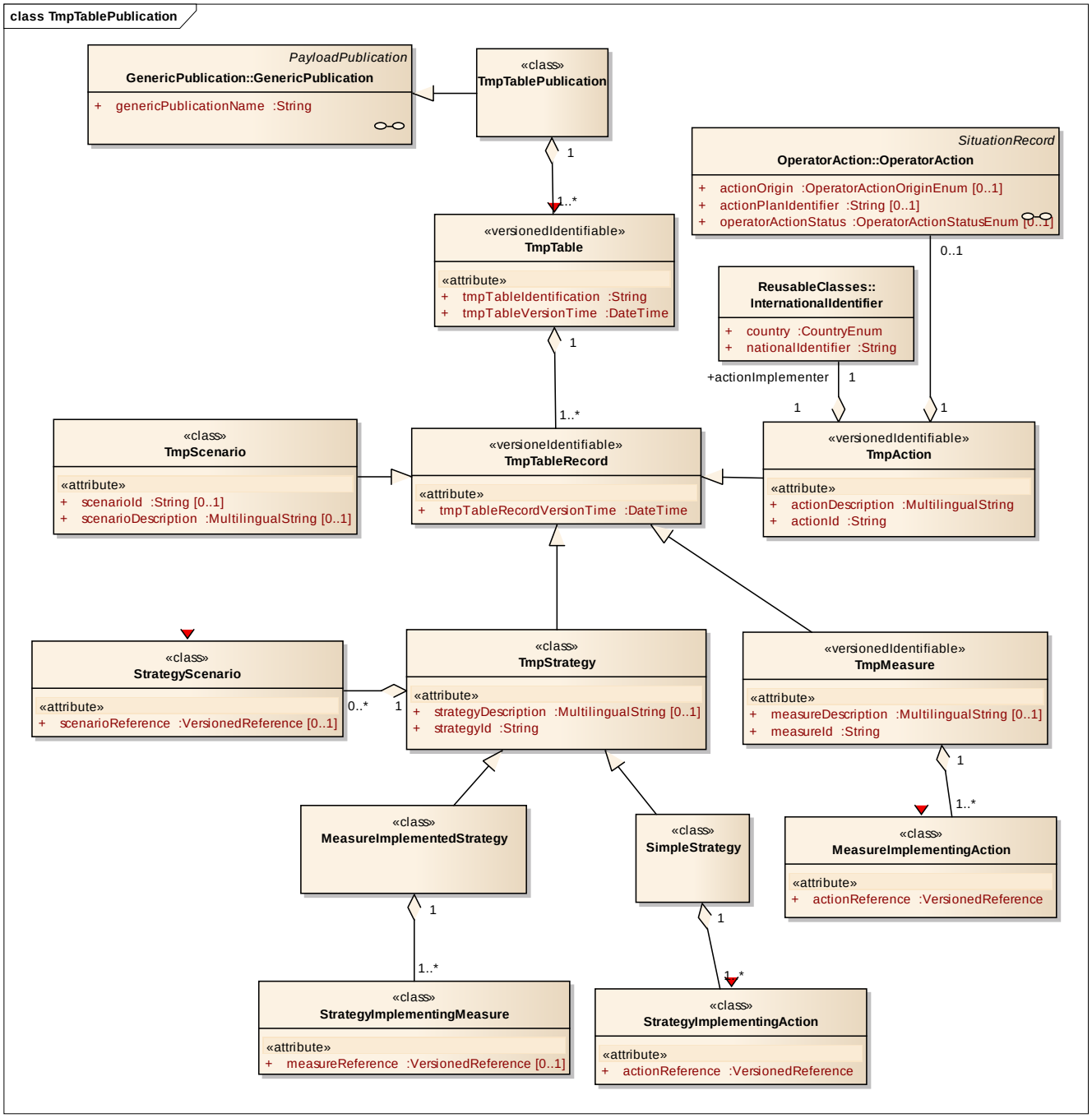


State definition are included in the ActivationStatusEnumeration and are defined in the following table.

Status Name	Status Definition
timeout	the request or implementation has not been anxwered or implemented within teh common agreed time.
approved	the proposed action or measure has been appvoed by (all) the operator(s) involved.
cancellationRequested	the action has been proposed to be cancelled by any of the operators.
Implemented	the measure or action approved has been implemented by any of the operators.
terminationRequested	the action has been proposed to be terminated by any of the operators.
cancelled	the proposal had been cancelled by the operator.
rejected	the proposal has been rejected by the operator.
proposed	the request has been received and has been proposed to the operator for approval or rejection.

TMP Table Publication

Class Diagram



TMPTablePublication is used to convey information relevant to predefined TMP that are organized in TMP Tables, which are created based on management convenience.

Classes

TmpTablePublication

Definition: Publication to convey information about stati definition of TMPlan related information defined at TMPlan design

TmpTable

Definition: a set of consistent TMPlan information agreed among TMPlan Implementers when designing TMPlan

Attribute	Datatype	Definition
tmpTableIdentification	String	Identification of TMP table
tmpTableVersionTime	DateTime	DateTime version of table

TmpTableRecord

definition = the record of a TMPlan Table

Attribute	Datatype	Definition
tmpTableRecordVersionTime	DateTime	The Date and time when the TmpTableRecord is created or updated

TmpScenario

definition = The TMPlan Table Record which identifies and describe a TMPlan Scenario.

Attribute		Definition
scenarioId	String	the common reference to an external identifier for the TMP Scenario, defined during theTMP Design Phase
scenarioDescription	MultilingualString	Description of scenario in natural languages

TmpAction

definition = The TMPlan Table Record which identifies and describe a TMPlan Action

Attribute	Notes	Definition
actionDescription	MultilingualString	Description of action needed to implement a specific Measure
actionId	String	the common reference to an external identifier for an Action among client and supplier, defined during theTMP Design Phase

TmpAction relevant Associations

An Action shall have an actionImplementer referring to InternationalIdentifier reusable class.

An action may be described in terms of an Operator Action on a specific Location by referencing the appropriate reusable classe OperatorAction. This are optional information as it may be assumed these information can be exchanged offline.

TmpMeasure

The TMPlan Table Record which identifies and describe a TMPlan Scenario

Attribute	Notes	Constraints and tags
scenarioId	String	the common reference to an external identifier for the TMPlan Scenario, defined during the TMPlan Design Phase
scenarioDescription	String	Description of scenario in natural languages

MeasureImplementingAction

definition = defines the Action which are needed to implement a Measure

Attribute	Notes	Definition
actionReference	VersionedReference	the common reference to an external identifier for an Action among client and supplier, defined during the TMPlan Design Phase.

TmpStrategy

definition = The TMPlan Table Record which identifies and describe a TMPlan Strategy.

Attribute	DataType	Definition
strategyDescription	MultilingualString	description of the Strategy in natural language
strategyId	String	the common reference to an external identifier for a Strategy among client and supplier, defined during the TMPlan Design Phase

StrategyScenario

definition = reference to possible Scenario(s) which need the TMPlan Strategy to be activated.

Attribute	DataType	Constraints and tags

Attribute	DataType	Constraints and tags
scenarioReference	VersionedReference	the common reference to an external identifier for the TMP Scenario, defined during the TMPlan Design Phase

MeasureImplementedStrategy

definition = the implementation of the Strategy is described by optional Measures to be implemented.

StrategyImplementingMeasure

definition = reference to Measure which mutually can implement the Strategy.

Attribute	Notes	Constraints and tags
measureReference	VersionedReference	the common reference to an external identifier for the TMPlan Scenario, defined during the TMPlan Design Phase

SimpleStrategy

definition = Strategy which implementation is based on Action to be implemented

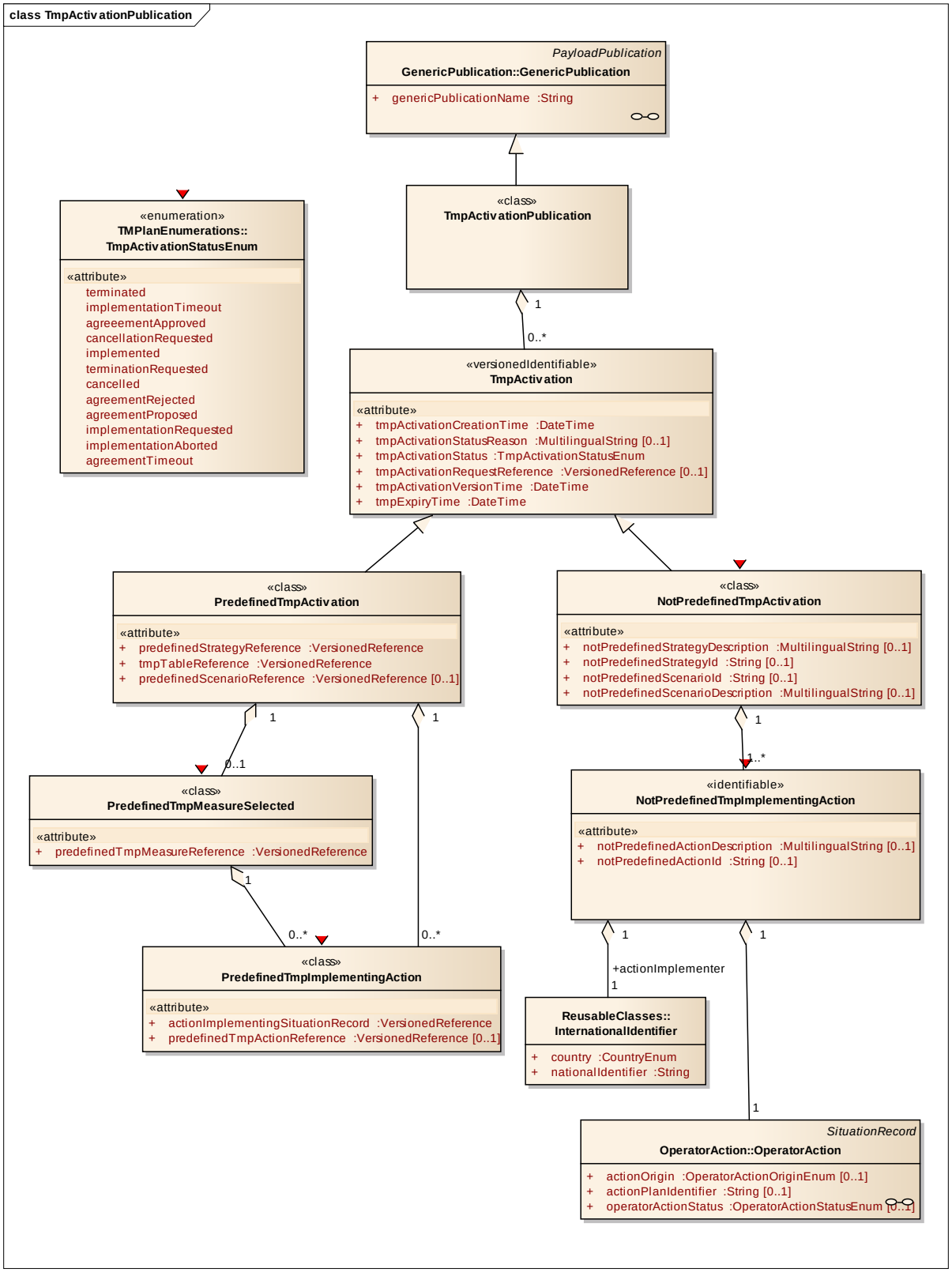
StrategyImplementingAction

definition = Reference to Action(s) which implement a Strategy.

Attribute	Datatype	Definition
actionReference	VersionedReference	the common reference to an external identifier for an Action among client and supplier, defined during theTMP Design Phase

TMP Activation Publication

Class Diagram



Classes

TmpActivationPublication

definition = Publication to convey information about Tmplan Activation information for service request and feedback and any informative or monitoring purposes.

TmpActivation

definition = the workflow procedure for agreeing and implementing a Traffic Management Plan

Attribute	DataType	Definition
tmpActivationCreationTime	DateTime	Creation Time ot the tmp Activation which is created to raise an agreement or implementation request.
tmpActivationStatusReason	MultilingualString	Textual description of the reasonof current TMPlan activation status.
tmpActivationStatus	TmpActivationStatusEnum	Status of TMPlan activation.
tmpActivationRequestReference	VersionedReference	Reference of the Service Request used to raise the agreement or implementation request for the TMPlan Activation.
tmpActivationVersionTime	DateTime	DateTime of current TMPlan Activaton version.
tmpExpiryTime	DateTime	DateTime of validity for current TMPlan Activation after which the TMPlanActivation is no further to be implemented by the TMPlan action implementer.

PredefinedTmpActivation

definition = Information about predefined TMPlan Activation.

Attribute	DataType	Definition
predefinedStrategyReference	VersionedReference	Reference to predefined TMPlan strategy which is requested or implemented.
tmpTableReference	VersionedReference	the reference to the TMPlan Table which define the predefined TMPlan Design informations and references
predefinedScenarioReference	VersionedReference	Reference to predefined TMPLan scenario which requires the current TMPlan Activation

PredefinedTmpMeasureSelected

definition = Information about predefined Measure which is requested or implemented in TMP Activation.

Attribute	DataType	Definition
predefinedTmpMeasureReference	VersionedReference	the reference to the specific predefined Measure chosen to implement the requested predefined TMPlan Strategy

PredefinedTmpImplementingAction

definition = Information about predefined Action in TMPlan activation

Attribute	DataType	Definition
actionImplementingSituationRecord	VersionedReference	Reference to situationRecord which has been created to implement the requested action by the action implementer
predefinedTmpActionReference	VersionedReference	the reference to the specific action defined in a predefined TMPlan for which the Situation Record is an implementation

NotPredefinedTmpActivation

definition = a set of information about not predefined TMPlan activation Strategy and Scenario used to address needed not predefined actions.

Attribute	DataType	Definition
notPredefinedStrategyDescription	MultilingualString	description of the not predefine Strategy in natural language
notPredefinedStrategyId	String	An identifier to be used as a common reference for the not Predefined Strategy among client and supplier
notPredefinedScenarioId	String	An identifier to be used as a common reference for the not predefined Scenario among client and supplier.
notPredefinedScenarioDescription	MultilingualString	description of the scenario in natural language

NotPredefinedTmpImplementingAction

definition = an action needed for implenenting a not predefine TMPlan Strategy

Attribute	DataType	Definition
notPredefinedActionDescription	MultilingualString	Description of action needed to implement a specific not predefined Strategy
notPredefinedActionId	String	the common reference to an external identifier for a not predefined Action among client and supplier, defined during theTMP Design Phase

NotPredefinedTmpImplementingAction relevant Associations

An Not Predefined Tmp Implementing Action shall have an actionImplementer referreing to InternationalIdentifierreusable class.

An Not Predefined Tmp Implementing Action may be described in terms of an Operator Action by referencing the appropriate reusable classe OperatorAction. This are mandatory information needed to request a specific action and relative detail information as OperatorAction.

TMP Activation Workflow Example

Referring the CIS Service Request and Feedack Workflow Description Section a TMP Activation will need following steps to be implemented in this Framework of Information Delivery of CIS Service/Request and TMP Activation

TMPlan implementation Steps

The following tables summarize the use of the various Publication in the CIS and TMPlan combined model.

	Supplier Action	active	TMPlan Involved Client Action
1.	Need for TMPlan		
2.	Publish TMPActivation Publication • tmpActivation ID • TMPactivationStatus= **agreeementProposed**	x	Receives TMPActivation waiting for further instructions
3.	Publish CIS **Service Request** • serviceRequestReference ID • elementToProcessVersionedReference = tmpActivaton ID of previous TMPActivation Publication • requestedAction=**agreement** •	x	Process CIS Service Request • process referenced TMPActivation Publication data to be managed for Operator agreement
4.	Waiting for Delivery of **Service Feedback** or **agreement timeout**		
5.	Get Service Feedack • serviceRequestReference • serviceActivationStatus		Deliver Service Feedback • serviceRequestReference=supplier ID • serviceActivationStatus = / scheduled / success / failed / rejectd
6.	Update TMPActivation Publication update • tmpActivation ID • TMPactivationStatus= **agreementApproved/ agreementRejected/ agreementTimeout**		Receives TMPActivation waiting for further instructions
7.	Update TMPActivation Publication update • tmpActivation ID • TMPactivationStatus= **implementationRequested**		Receives TMPActivation waiting for further instructions
8.	Publish CIS **Service Request** • serviceRequestReference ID • elementToProcessVersionedReference = tmpActivaton ID of previous TMPActivation Publication • requestedAction=**implement**	x	Process CIS Service Request • process referenced TMPActivation Publication data to be managed for Operator agreement

9.	Waiting for Delivery of **Service Feedback** or **implementation timeout**		
10.	Get Service Feedack • serviceRequestReference • serviceActivationStatus		Deliver Service Feedback • serviceRequestReference=supplier ID • serviceActivationStatus
11.	Publish TMPActivation Publication update • TMPactivationStatus= **implementationRequested/ implemented/ implementationAborted/ implementationTimeout**		

Service Activation Status vs TMP Activation Status relationship

Following table summarize TMPactivationStatus consistently derived from corresponding ServiceRequest and ServiceFeedback Status.

Publication activity	**Service Request requestedAction**	**Service Feedback serviceActivationStatus**	**TMP Publication TMPactivationStatus**
TMP Publication created			**agreeementProposed**
Service Request created	agreement		
Service Feedack	agreement	success	**agreementApproved**
	agreement	*failed*	***agreementRejected***
	agreement	rejected	**agreementRejected**
	agreement	no- response	**agreementTimeout**
TMP Publication update			**implementationRequested**
Service Request created	implement		
Service Feedback	implement	success	Implemented
	implement	failed	implementationAborted
	implement	*rejected*	implementationAborted
	implement	no- response	implementationTimeout
TMP Publication updated			Implemented / implementationAborted / implementationTimeout /

Subsequent TMP implemented update follow a similar scheme via agreement and implement Service Requests

Cancellation, termination are requested and monitored via Service Request as well.