OPCAT Version 3.0

Getting Started Guide

June 2007

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1. Intrudction to the Guide

The purpose of this Guide is to help OPCAT user to start modeling with OPCAT 3.0. The Guide focuses on the Object Process Methodology which serves as the basis for OPCAT advanced features. After reading the guide the user is encouraged to continue to the advanced lessons which could be obtained by contacting us at consulting@opcat.com.

This Guide is divided into sections; each section describes another aspect of the OPM language or the OPCAT program and contains a summary at the end.

2. Brief Formal Introduction to OPM

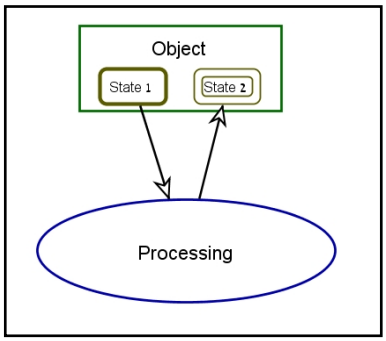


Figure 1: An Object-Process Diagram (OPD) showing the three OPM entities: Object, Process, and State, and the input/output procedural link pair, which expresses that Processing changes Object from State 1 to State 2.

Object Process Methodology (OPM) is a holistic approach for conceptual modeling of complex systems. The OPM model integrates the functional, structural, and behavioral aspects of a system in a single, unified view, expressed bi-modally in equivalent graphics and text with built-in refinement-abstraction mechanism.

Two semantically equivalent modalities, one graphic and the other textual, jointly express the same OPM model. A set of inter-related hierarchically organized Object-Process Diagrams (OPDs), showing portions of the system at various levels of detail, constitute the graphical, visual OPM formalism. The OPM ontology comprises entities and links. Each OPM element (entity or link) is denoted in an OPD by a symbol, and the OPD syntax specifies correct and consistent ways by which entities can be connected via structural and procedural links, such that each legal entity-link-entity combination bears specific, unambiguous semantics (see Figure 1 for example). There are three different types of entities: objects, processes (collectively referred to as "things"), and states. These entities are shown in Figure 1. Objects are the (physical or informatical) things in the system that exist, and if they are stateful (i.e., have states), then at any point in time they are at some state or in transition between states. Processes are the things in the system that transform objects: they generate and consume objects, or affect stateful objects by changing their state.

Links can be structural or procedural. Structural links express static, time-independent relations between pairs of entities. The four fundamental structural relations are aggregation-participation, generalization-specialization, exhibition-characterization, and classification-instantiation. General tagged structural links provide for creating additional "user-defined" links with specified semantics. Procedural links connect processes with objects or object states to describe the behavior of a system. System behavior is manifested in three ways: (1) a processes can transform (generate, consume, or change the state of) one or more objects; (2) an object can enable one or more processes without being transformed by them, in which case it acts as an agent (if it is human) or an

instrument; and (3) an object can trigger an event that invokes a process if some conditions are met. Accordingly, a procedural link can be a transformation link, an enabling link, or an event link. A transformation link expresses object transformation, i.e., object consumption, generation, or state change. Figure 1 shows a pair of transformation links, the input/output link. It expresses in OPL that Processing changes Object from State 1 to State 2. An enabling (agent or instrument) link expresses the need for a (possibly state-specified) object to be present in order for the enabled process to occur. The enabled process does not transform the enabling object. An event link connects a triggering entity (object, process, or state) with a process that it invokes.

The System Diagram, SD, is the topmost diagram in a model. It presents the most abstract view of the system, typically showing a single process as the main function of the system, along with the most significant objects that enable it and the ones that are transformed by it. The further from the root the OPD is, the more detailed it is. Each OPD, except for the SD, is obtained by refinement—in-zooming or unfolding—of a thing (object or process) in its ancestor OPD. This refined thing is described with additional details. The abstraction-refinement mechanism ensures that the context of a thing at any detail level is never lost and the "big picture" is maintained at all times.

A new thing (object or process) can be presented in any OPD as a refineable (part, specialization, feature, or instance) of a thing at a higher abstraction level (a more abstract OPD). It is sufficient for some detail to appear once in some OPD for it to be true for the system in general even though it is not shown in any other OPD. Accordingly, copies of a thing can appear in other diagrams, where some or all the details (such as object states or thing relations) that are unimportant in the context of a particular diagram need not be shown.

The Object-Process Language (OPL) is the textual counterpart modality of the graphical OPD set. OPL is a dual-purpose language, oriented towards humans as well as machines. Catering to human needs, OPL is designed as a subset of English, which serves domain experts and system architects, jointly engaged in modeling a complex system. Every OPD construct is expressed by a semantically equivalent OPL sentence or phrase that is generated automatically by OPCAT in response to the user's input. According to the modality principle of the cognitive theory of multimodal learning, this dual graphic/text representation of the OPM model increases the human processing capability. It has indeed been our experience that humans enhance their understanding of the model as they conveniently draw upon the graphic and/or the textual model representation to complement what they missed in the other modality.

A major problem with most graphic modeling approaches is their scalability: As the system complexity increases, the graphic model becomes cluttered with symbols and links that connect them. The limited channel capacity is a cognitive principle which states that there is an upper limit on the amount of detail a human can process before being overwhelmed. This principle is addressed by OPM and implemented in OPCAT with three abstraction/refinement mechanisms. These enable complexity management by providing for the creation of a set of interrelated OPDs (along with their corresponding OPL paragraphs) that are limited in size, thereby avoiding information overload and enabling comfortable human cognitive processing. The three refinement/abstraction mechanisms

are: (1) unfolding/folding, which is used for refining/abstracting the structural hierarchy of a thing and is applied by default to objects; (2) in-zooming/out-zooming, which exposes/hides the inner details of a thing within its frame and is applied primarily to processes; and (3) state expressing/suppressing, which exposes/hides the states of an object.

The software environment embodied in the OPCAT 3 product supports OPM-based system development, evolution, lifecycle engineering, and lifecycle management. This software package implements the bimodal expression of the OPM model along with many new model-based capabilities. In addition to OPM-based systems modeling, the OPCAT platform supports such features as requirements engineering, information layers management, model repository, simulation and validation of the model, and automatic document generation and management.

OPM Basics: A Quick Summary

- OPM is a modeling language based on the paradigm that views processes and objects as equally important in the system model.
- OPM uses **Objects** and **Processes** in order to model the structural and behavioral aspects of a system.
- **Objects** are things that exist over time. Object can be **stateful** (i.e., have states).
- **Processes** are things that transform **Objects** by creating them, destroying them, or changing their states.
- **Procedural links** connect processes to objects to express these transformations.
- **Structural relations** connect objects to express static, long-term between them.

3. *Starting to Model with OPCAT*

The OnStar System, specified in Annex A in free text, is used as a running example throughout this guide.

A detailed, step-by-step OPM-based model construction of the OnStar System is used to explain how to do the modeling with OPCAT by describing almost each mouse-click, so you, as a new user, can closely follow each step and reproduce the model as you proceed with following the model while it is being constructed in the pages below.

3.1 *Install* OPCAT

OPCAT is standalone software. Press Setup file and install OPCAT. Note that you are required to select directory in which OPCAT models will be saved. You are also required to restart your computer after installation. Note that Java 6JRE is required.

3.2 Open a new system

Double clicking the green OPCAT icon application, a blank screen is opened, as shown in Figure 2.

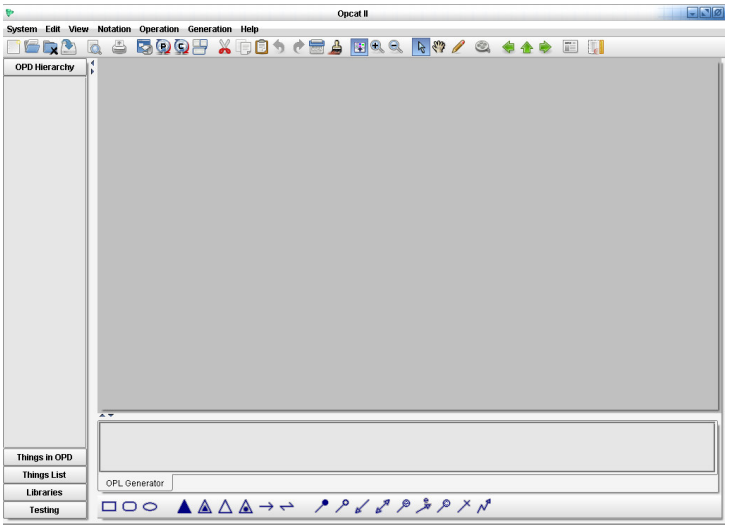


Figure 2. A blank OPCAT opening screen

Clicking **System -> New** we get the **New System Properties** dialog box shown in Figure 3.

Fill in the details and click **OK**. At this point you may also want to save the system in a designated folder.

Next we start modeling the system in the *System Diagram*.

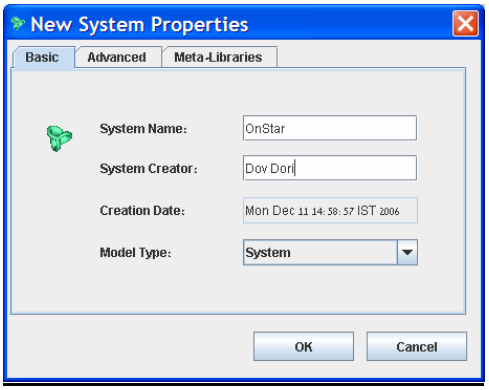


Figure 3. The New System Properties dialog box

3.3 The System Diagram (SD)

The ***System Diagram*** (SD) is the first, top-level Object-process Diagram (OPD) of our system.
SD expresses clearly the main system's function – what it is designed to do, the beneficiary, the main objects that are consumed, created, and/or affected by that function, the main human and non-human enablers of the system, and the objects which interact with our system (called environmental, as opposed to systemic).

3.4 Defining the system main function

We now start to actually model the OnStar system. We do this by drawing model elements – processes, objects, and links – on the graphic screen, the top right pane marked as *SD*, short for System Diagram. As we model, we inspect the translation in real-time of our graphic editing into OPL – Object-Process Language – to make sure we have done the right thing.

The first thing we need to do when modeling a new system is to **define the system's major function**. This is going to be the central process which we will draw in the center of the SD. The major function of the OnStar system is Driver Rescuing.

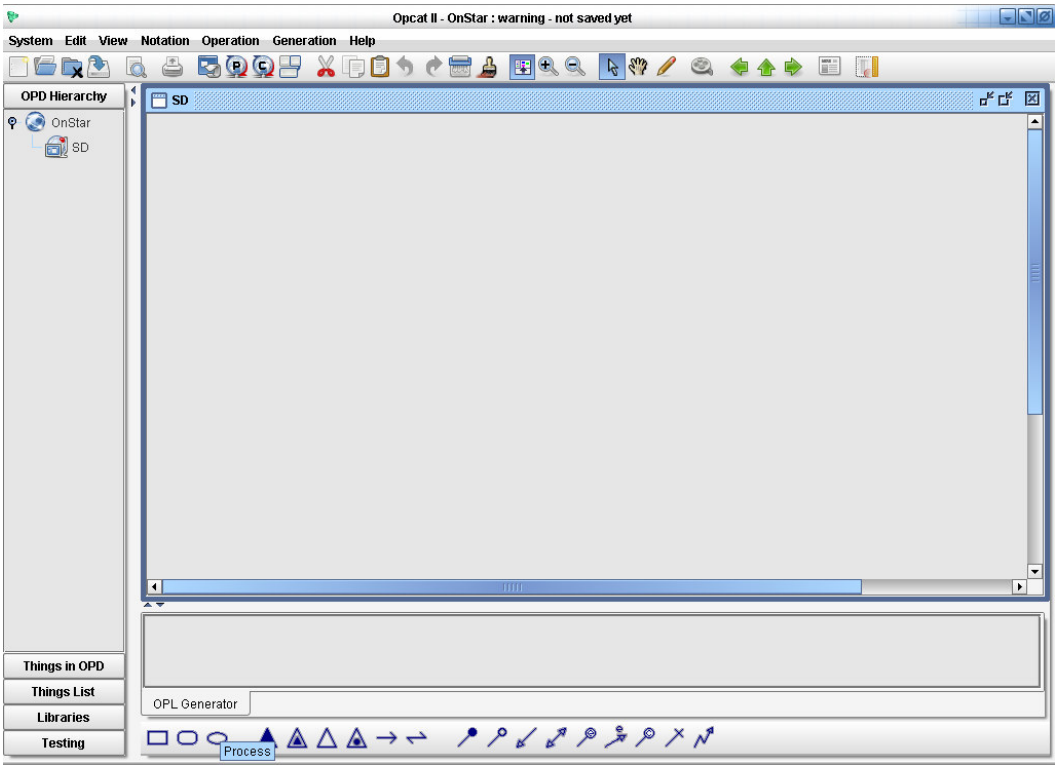


Figure 4. OPCAT Screen after opening the new OnStar System model

Sliding the mouse over the OPM symbols in the bottom toolbox shows their name. In Figure 4 the mouse is over the ellipse and we see that the ellipse is the symbol for a process. Click on the process icon (the ellipse, third from the bottom left toolbar, see Figure *24*). You will get the dialog window shown in Figure 5. Type the process name. Since this process is physical, click on the **physical essence** radio button and click OK.

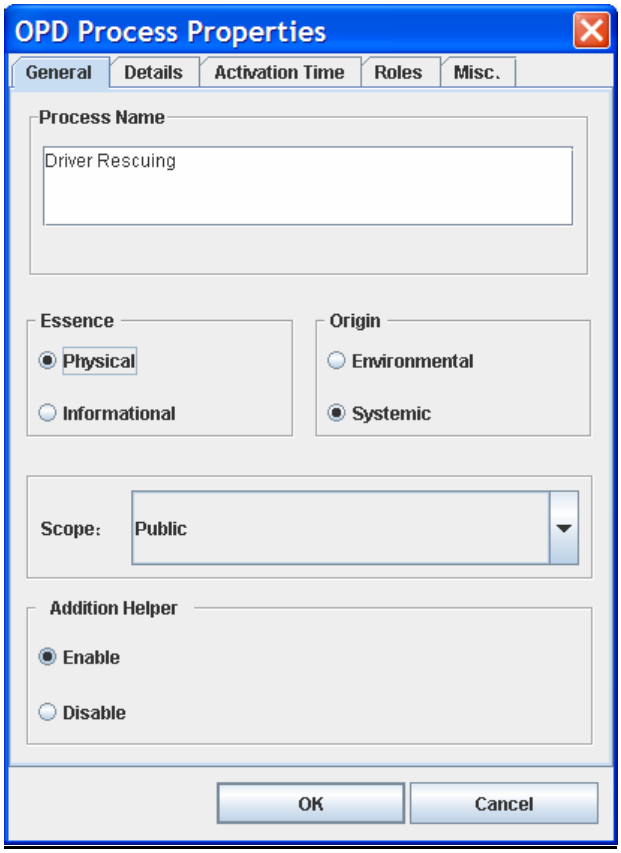


Figure 5. The Process Properties dialog box

You should get the process as shown in Figure 6. Note that the process is shaded to denote that its **essence** attribute is **physical** (the default essence of OPM things – processes as well as objects – is **informatical**).

Note also that the following OPL sentence appeared in the bottom right pane:

Driver Rescuing is physical.

To help distinguishing between objects and processes, the process name in the text is in blue, as it is in the OPD. Objects will be green.

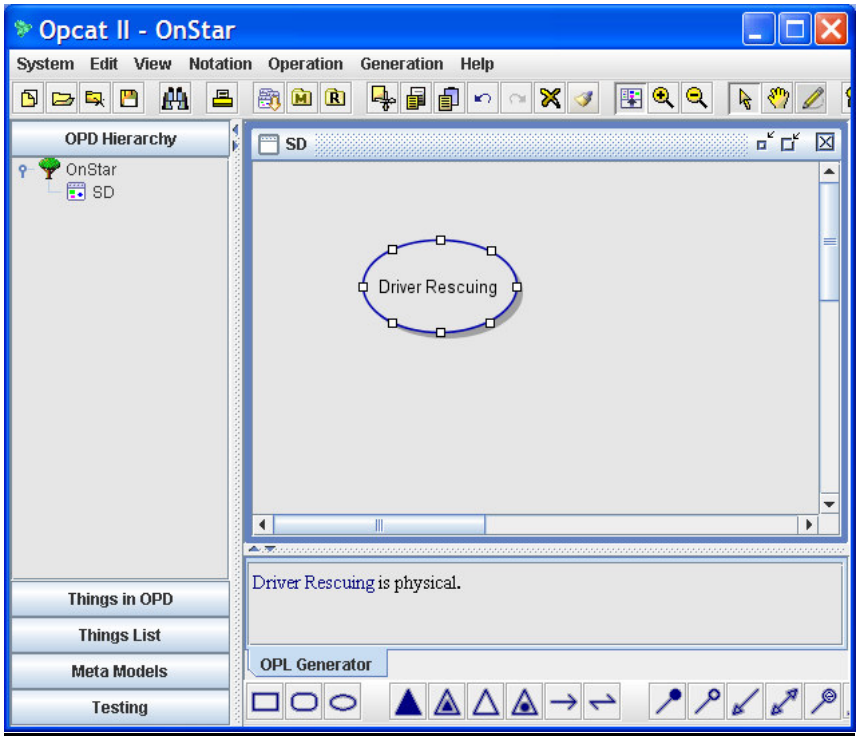


Figure 6. **Driver Rescuing**, the main function of the system, has been inserted as a physical process.

3.5 Defining and linking the system's main objects

Having defined the major system function, we now turn to depicting the main objects in the system. We need to think first who is the beneficiary of the system, i.e., who gets value from the systems. Obviously, it is the driver, so we insert **Driver** as a physical object. Since the driver is not part of the system, but interacts with it, its **affiliation** is **environment** rather than **system**, so we mark both radio buttons and get the OPL sentence:

Driver is environmental and physical.

Another vital object in the mode is the **OnStar System**, which we also add as a physical object. Figure 7 shows SD, the System Diagram, after the objects **Driver** and **OnStar System** were added.

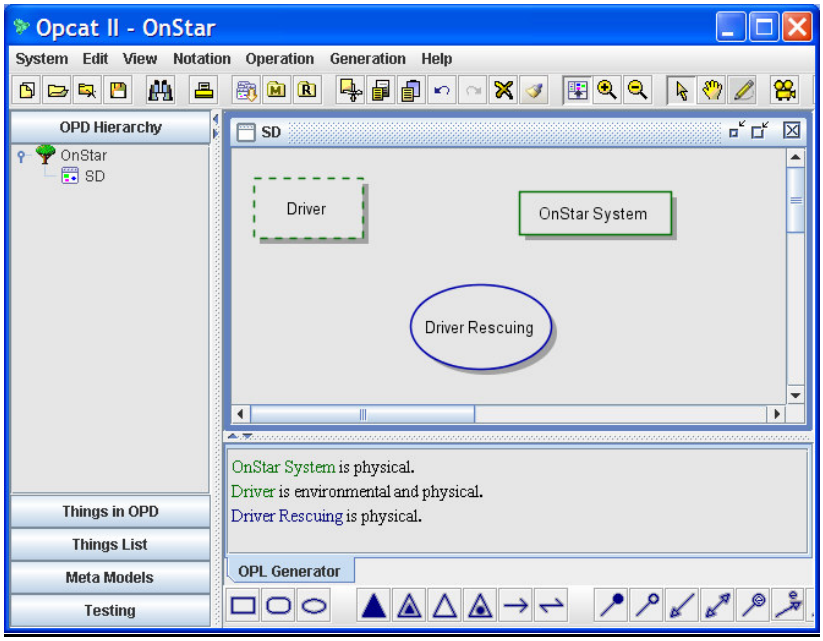


Figure 7. SD after adding the two objects

As the beneficiary, **Driver** is affected by the **Driver Rescuing** process. To denote this, click on the effect link symbol – the bidirectional arrow at the bottom right, then click on the process and drag it from the process to the object. The result, shown in Figure *19*, is expressed in a new OPL sentence:

Driver Rescuing affects Driver.

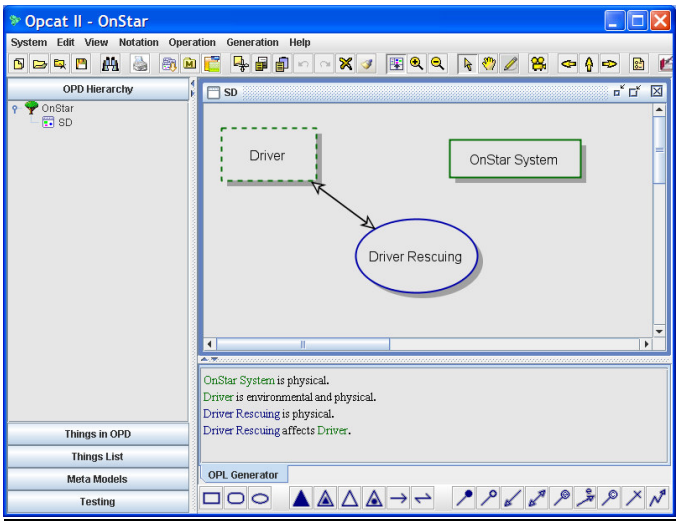


Figure 8. SD after linking **Driver** and **Driver Rescuing** with an effect link

The semantics of this sentence is that the **Driver**'s state is changed by the **Driver Rescuing** process, but at this abstract level of detail, the states themselves are not specified, so the effect link abstracts this expression. At a later stage we will describe the relationship between the **Driver** and **Driver Rescuing** process in more details. In this sense Effect link is a generalization of the detailed description to come.

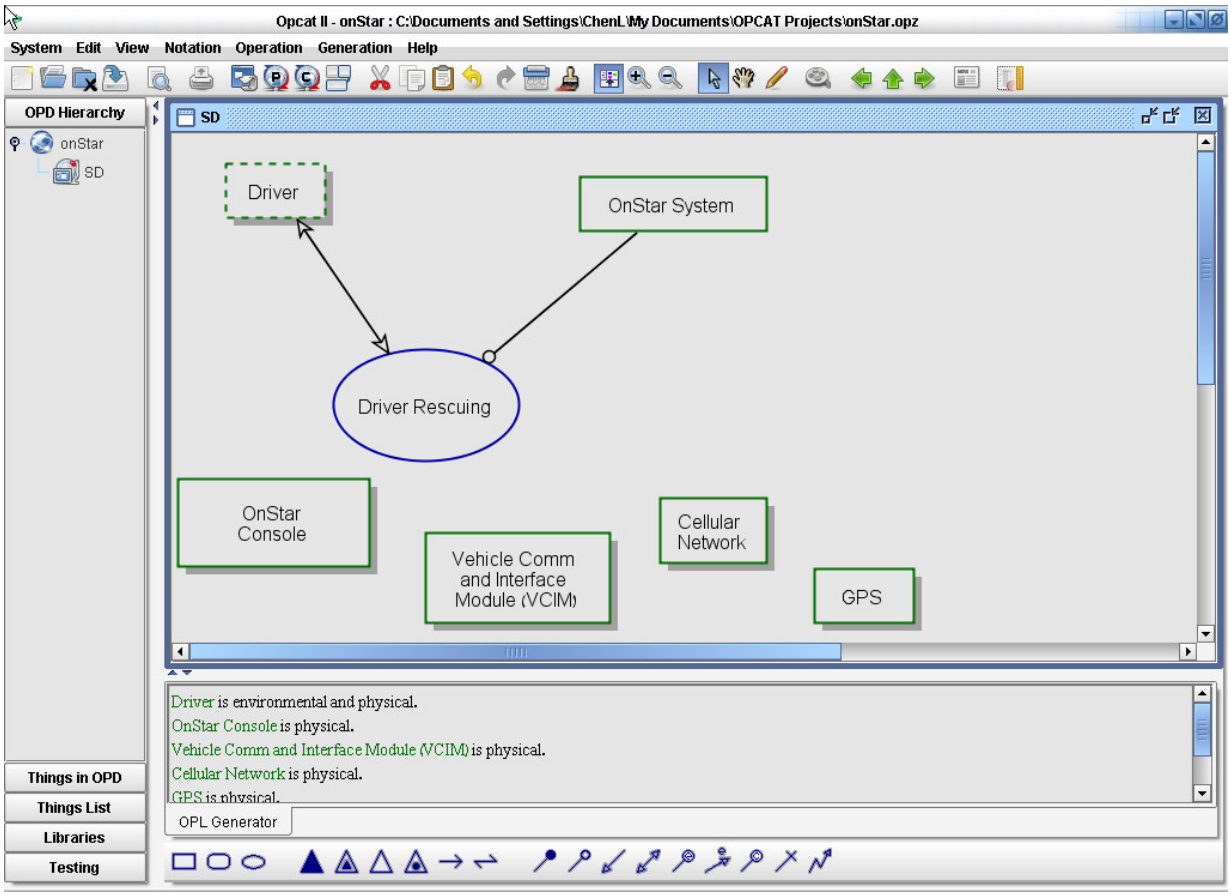


Figure 9. Adding the four parts of OnStar System

Next, in Figure 9, the **OnStar System** is added as an instrument to the **Driver Rescuing** process. This is done by clicking on the instrument link button – the line with the white circle (white lollipop) – and dragging it from the **OnStar System** – the instrument – to the **Driver Rescuing** process. The sentence added as a result is:

Driver Rescuing requires OnStar System.

Reading the OnStar description we find that " At its most basic, OnStar consists of four different systems: cellular phone, voice recognition, GPS and vehicle telemetry."

We now wish to model this sentence, which describes the parts of the OnStar System. Adding the four parts of OnStar System is shown in Figure 9.

The parts are added one by one. The location of each object is determined by where we click on the screen after selecting the Object button.

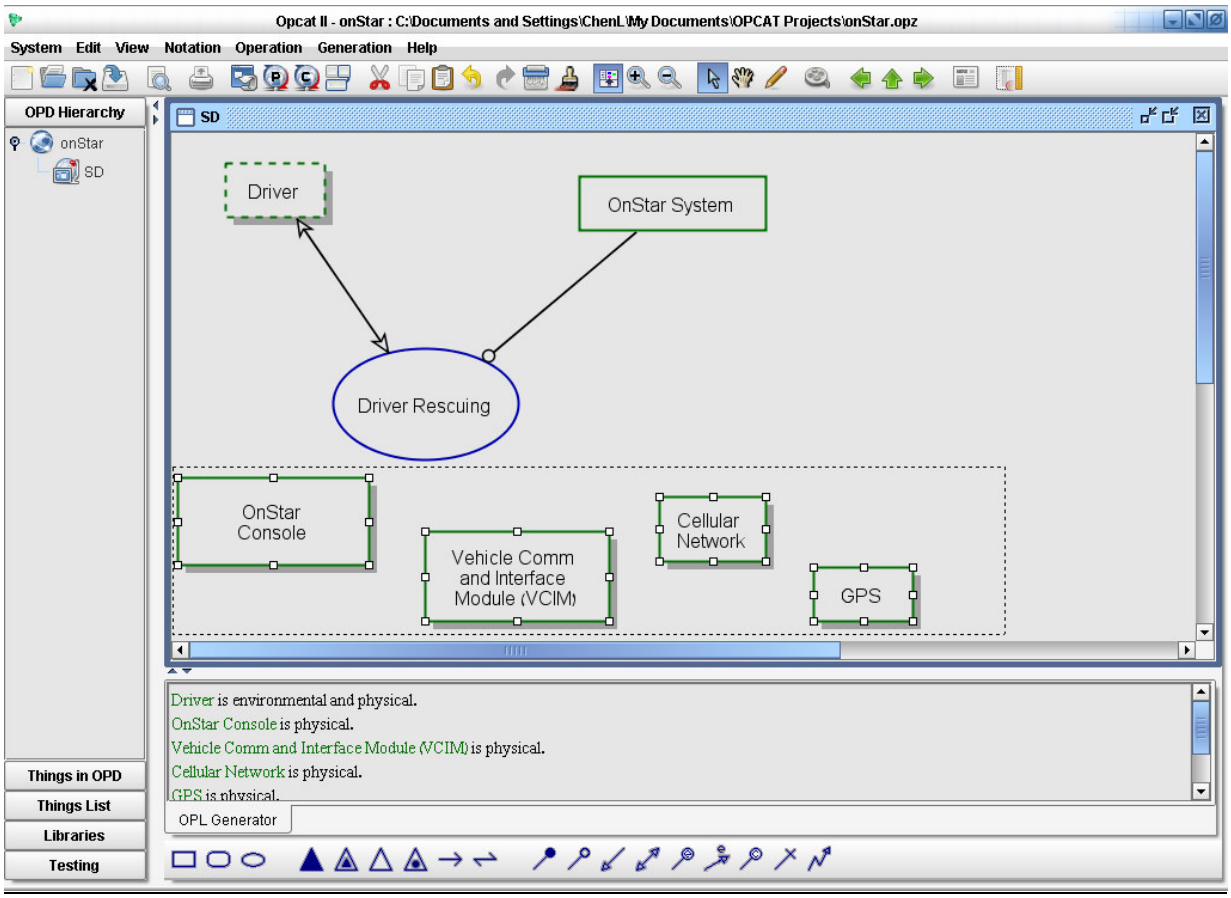


Figure 10. Marking the four parts of OnStar System for horizontal alignment

Naturally, the objects are therefore not quite aligned, and we may wish to align them. Marking the four parts of OnStar System for horizontal alignment is shown in

Figure *10*. We mark all at once by clicking and dragging the mouse to include all the things we wish to mark within the dotted area. The marking is shown by small white squares on each object.

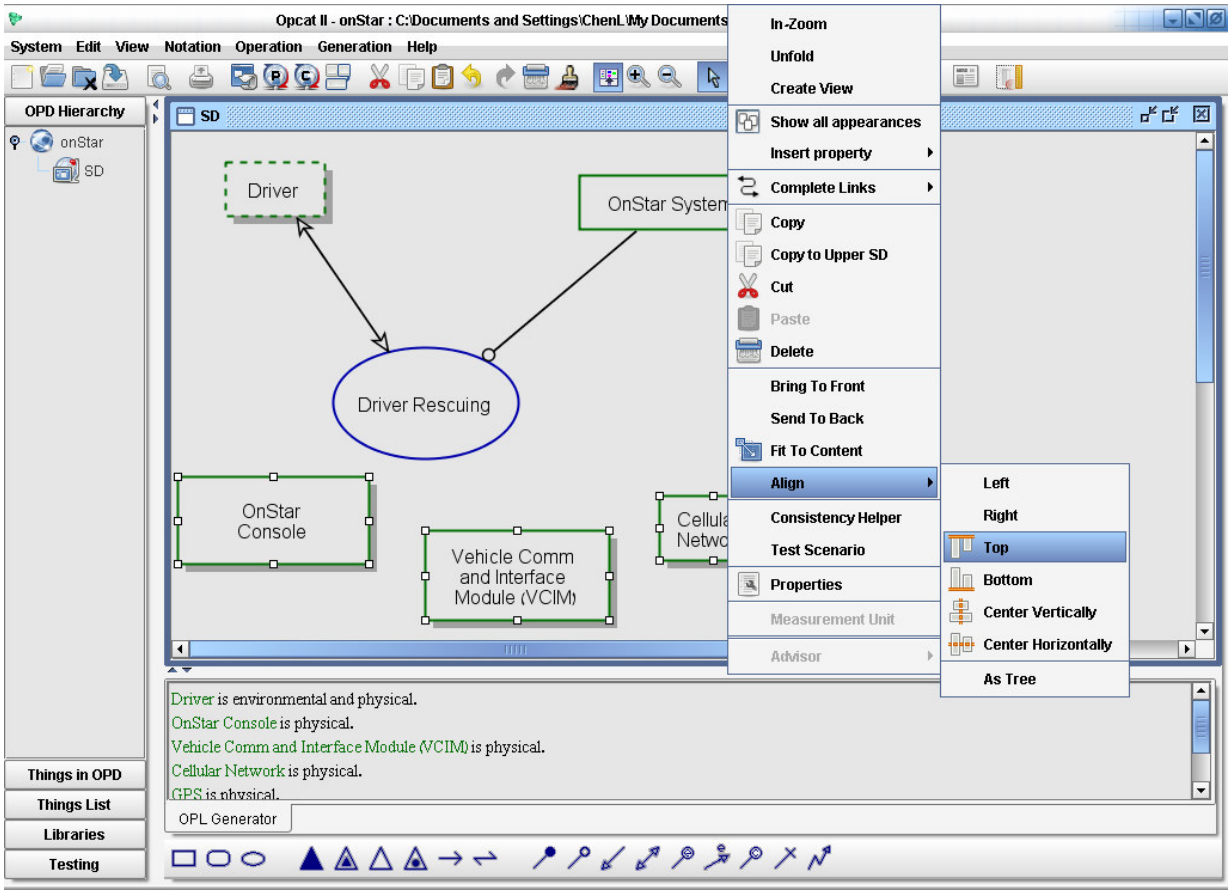


Figure 11. Top alignment of the four parts of OnStar System

Right Clicking on one of the four marked objects brings the pop-up menu shown in Figure *11*, and clicking "Align" brings a sub-menu, from which we select "Top".

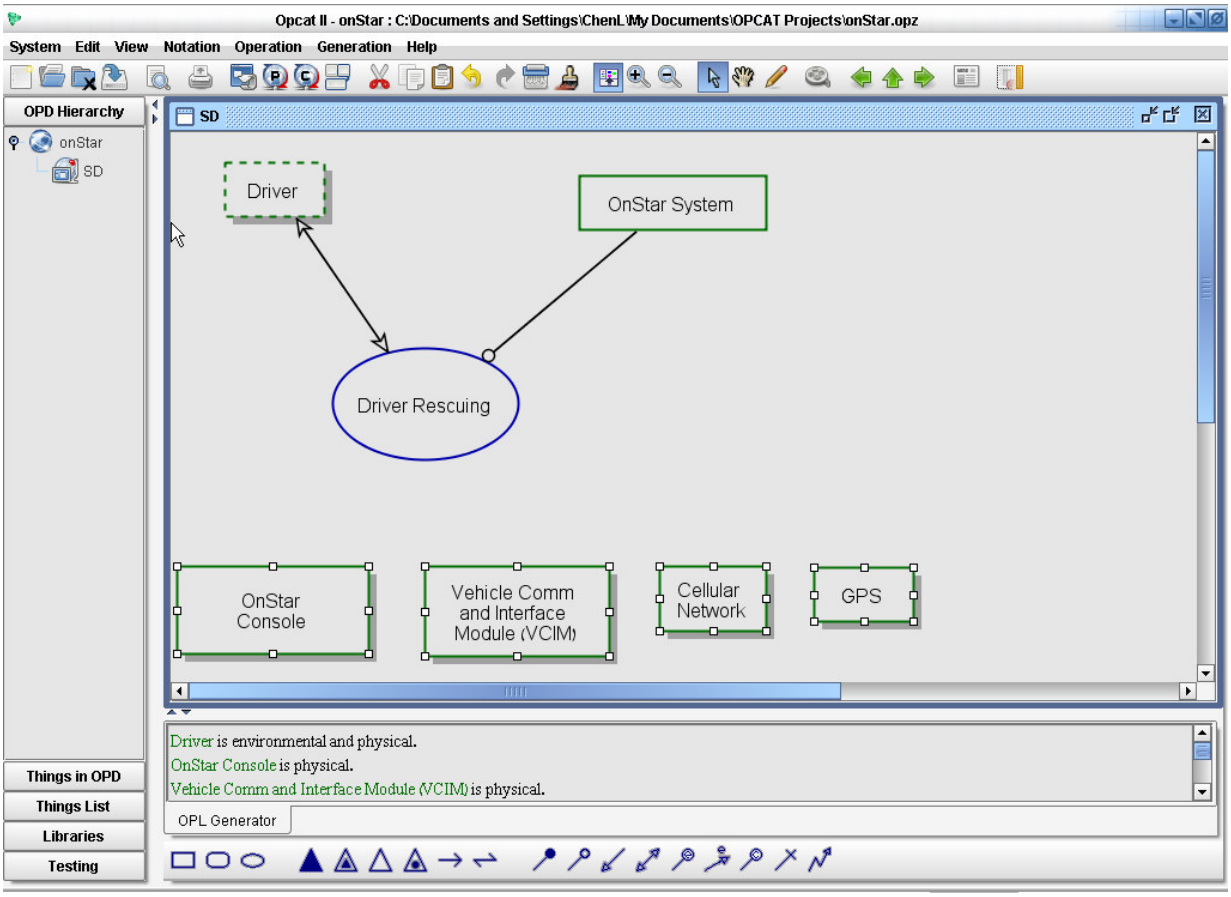


Figure 12. The four parts of OnStar System after top alignment

The result of the aligned objects is shown in

Figure *12*.

At this point, we wish to denote the fact that all these four objects are part of the OnStar System. This is an opportunity to introduce the set of OPM symbols which appear at the bottom of the screen.

3.6 Quick Summary

- The first **OPD** (the **SD**) is used to establish the main function of the system and the objects involved in this process.
- We start off by modeling the main function of the system as the central process in SD.
- **Things (Objects or Processes)** have an **Essence** attribute and an **Affiliation** attribute.
- The default **Essence** is **informatical** and the default **Affiliation** is **systemic**.
- **Things** which are not informatical (such as file, command, message, algorithm) will be marked as **physical.**
- **Things** which are not **systemic** – not part of the system (but interact with it) – will be marked as **environmental.**
- Environmental objects interact with our system but we have no influence on their design.
- The system can affect environmental objects but it is not responsible for creating them.
- We add the main objects in the system, denoting, if needed, their **Essence** as **physical** and their **Affiliation** as **environmental**.
- Each part of the system which will be modeled later is some refinement (specification of parts, specializations, or features) of the Things in the **SD**.

4. The OPM symbols

The OPM symbol buttons at the bottom of the screen are divided into three groups. The next three figures present in tabular form each one of the three symbol groups.

3.7 Entities

The group on the left is the group of the entities: Object, state, and process.

Symbol		Name: Definition	OPL	Allowed Source-to-Destination connections	Semantics/ Effect on the system flow/ Comments
Things		Object **A**: A thing that exists	**A** is physical [and environmental].		**A** is informatical and systemic by default.
		Process **B**: A thing that transforms (generates, consumes, or changes the state of an) object.	**B** is physical [and environmental].		**B** is informatical and systemic by default.
		State: A situation of an object.	**A** is s1. **A** can be s1 or s2. **A** can be s1, s2, or s3.		Always within an object.

Figure 13. The OPM entities

3.8 Structural Links

In the middle is the group of the structural links: four triangles and two arrows with open heads.

The structural links denote static, long-term relations that have no relation to the time dimension and hold true throughout the system's existence between an object and other objects or between a process and other processes.

Symbol	**Name: Definition**	**OPL**	**Allowed Source-to-Destination connections**	**Semantics/ Effect on the system flow/ Comments**
▲	Aggregation-Participation	**A** consist of **B**.	Object-Object Process- Process	Whole -Part
◬	Exhibition-Characterization	**A** exhibits **B**.	Object-Object Object-Process Process-Object Process- Process	
△	Generalization-Specialization	**B** is an **A**. (objects) **B** is **A**. (processes)	Object-Object Process- Process	
◬	Classification-Instantiation	**B** is an instance of **A**.	Object-Object Process- Process	
→ ⇄	Tagged structural links: Unidirectional Bidirectional	According to text added by user	Object-Object Process- Process	Describes structural information.

Figure 14. The structural links

3.9 Procedural Links

The OPM symbols grouped on the left are the procedural links: four triangles and two arrows with open heads.

The procedural links denote dynamic, transient relations that have everything to do with the time dimension. Opposite to the structural links, they connect an object and a process but not an object to another object.

Symbol	**Name: Definition**	**OPL**	**Allowed Source-to-Destination connections**	**Semantics/ Effect on the system flow/ Comments**
	Agent Link	**A** handles **B**.	Object (A) to Process (B)	Denotes a human operator. Activating the link triggers the process B.
	Instrument Link	**B** requires **A**.	Object (A) to Process (B)	Wait until A is generated and exists.
		B requires s1 **A**.	State (s1) to Process (B)	Wait until A is at state s1.
	Condition Link	**B** occurs if **A** exists.	Object (A) to Process (B)	Execute if object A exists, and if not then skip process B and continue the regular system flow.
		B occurs if **A** is s1.	State (s1) to Process (B)	Execute if object A is at state s1, and if not then skip process B and continue the regular system flow.
	Effect Link	**B** affects **A**.	Object (A) to Process (B)	Used when details of the effect are not necessary or will be add at a lower level (also created when states lined to a process with an input-output pair are hidden-suppressed) Affect at an high level signifies at lower levels – • State changes • Consumption and later generation

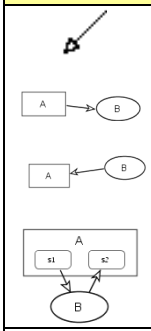
Symbol	Name: Definition	OPL	Allowed Source-to-Destination connections	Semantics/ Effect on the system flow/ Comments
	Consumption Link Result Link Input-Output Link Pair	**B** consumes **A.** **B** yields **A**. **B** consumes s1 **A.** **B** yields s1 **A**. **B** changes **A** from s1 to s2.	Object to Process Process to Object State to Process Process to State Process – State s1 to Process and Process to s2.	Process consumes the object. Process creates the object. Process changes the state of object.
	Invocation Link	**B** invokes **C**.	Process-Process	Execution will proceed if the triggering failed (due to failure to fulfill one or more of the conditions in the precondition set).
	Instrument Event Link	**A** triggers **B**. s1 **A** triggers **B**.	Object (A) to Process (B) State (s1) to Process (B)	Execution will proceed if the triggering failed (due to failure to fulfill one or more of the conditions in the precondition set). For normal, non-triggered execution, the object or state linked is not required for the process to take place.
	Consumption Event Link	**A** triggers **B**, which, if occurs, consumes **A**. s1 **A** triggers **B**, which, if occurs, consumes **A**.	Object (A) to Process (B) State (s1) to Process (B)	Execution will proceed if the triggering failed (due to failure to fulfill one or more of the conditions in the precondition set). For normal, non-triggered execution, the object or state linked is not required for the process to take place.

Figure 15. The procedural links

3.10 *Using structural relations*

Structural relations are used to model the structure of the system.

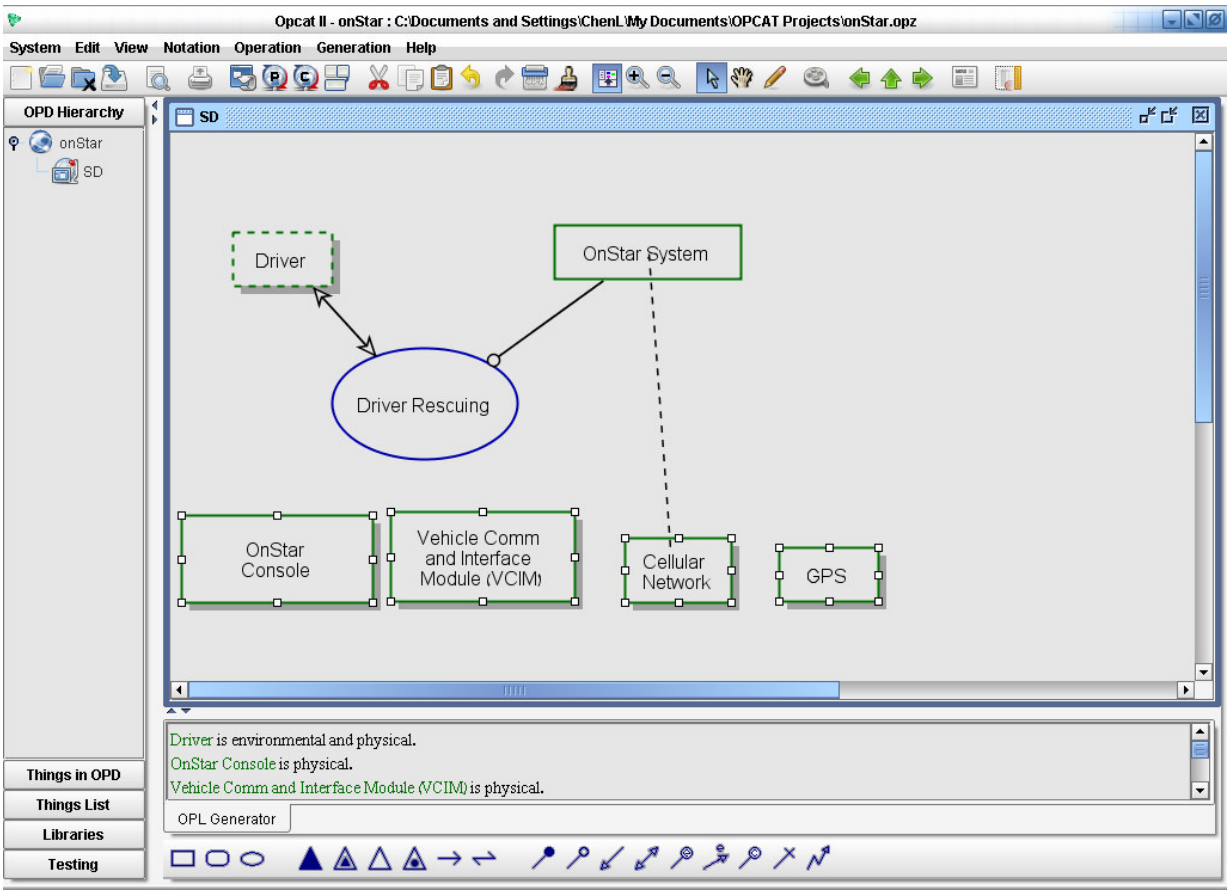


Figure 16. Linking the Cellular Network part of OnStar System to the whole OnStar System

To denote the fact that the four marked objects in Figure 16 are parts of OnStar System we click on the solid (black or blue) triangle and then click the mouse on the whole – the OnStar System – and drag it to one of the parts, e.g., Cellular Network.

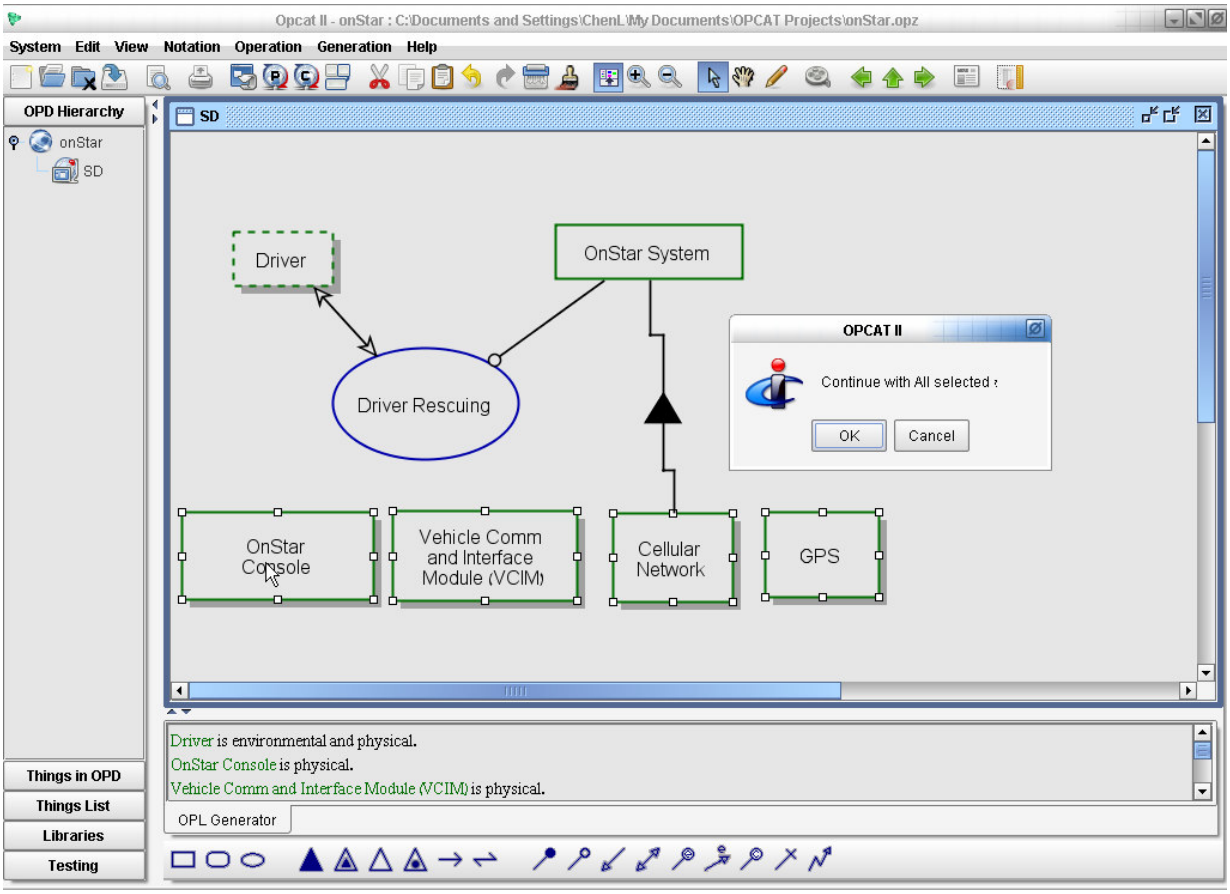


Figure 17. The question asked after linking Cellular Network to the whole OnStar System

Since several objects are marked, a question shown in

Figure 17 appears, asking whether we wish to continue with all the selected objects, i.e., are they too parts of the whole.

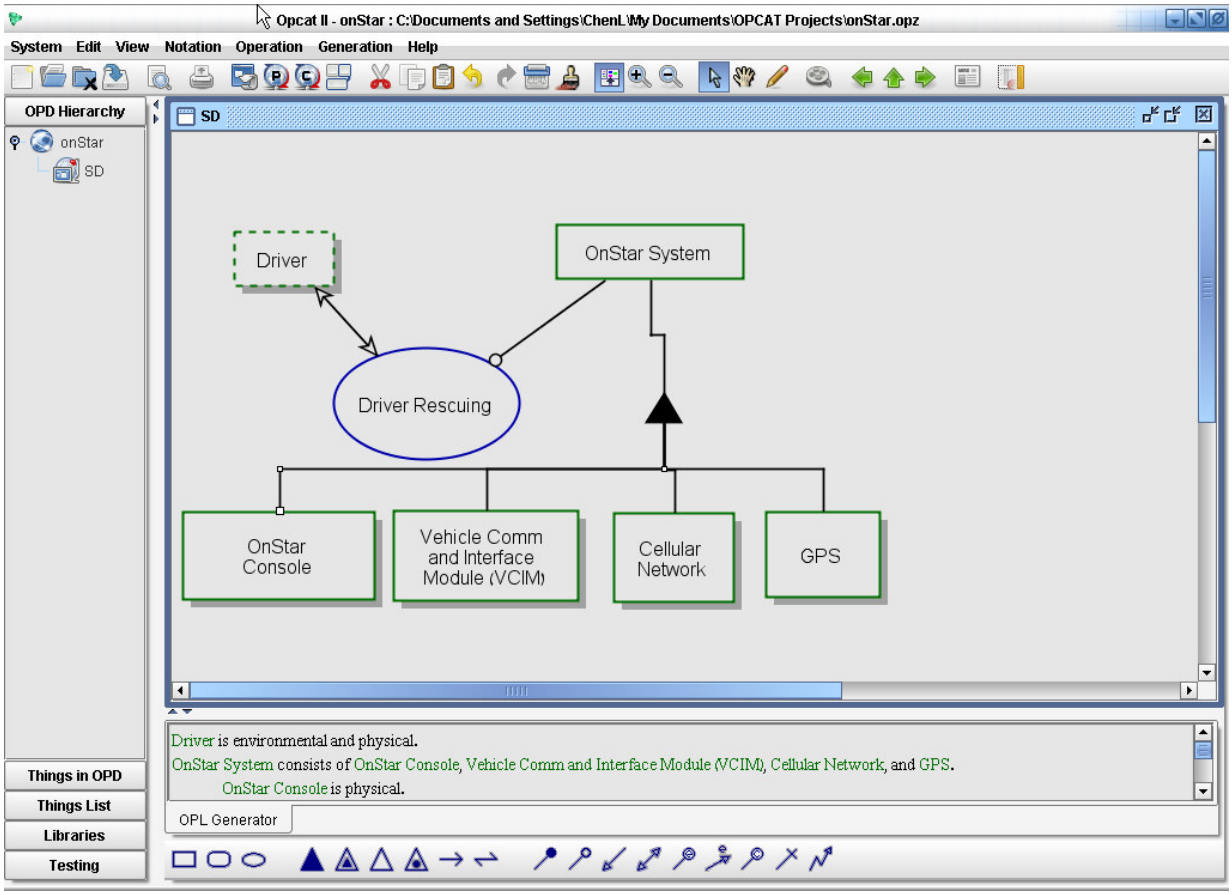


Figure 18. The four parts of Cellular Network are now linked to the whole OnStar System

Clicking OK will generate the four links in

Figure *18*.

The resulting OPL sentence, shown in the second line of the OPL pane, is:

OnStar System consists of OnStar Console, Vehicle Comm and Interface Module (VCIM), Cellular Network, and GPS.

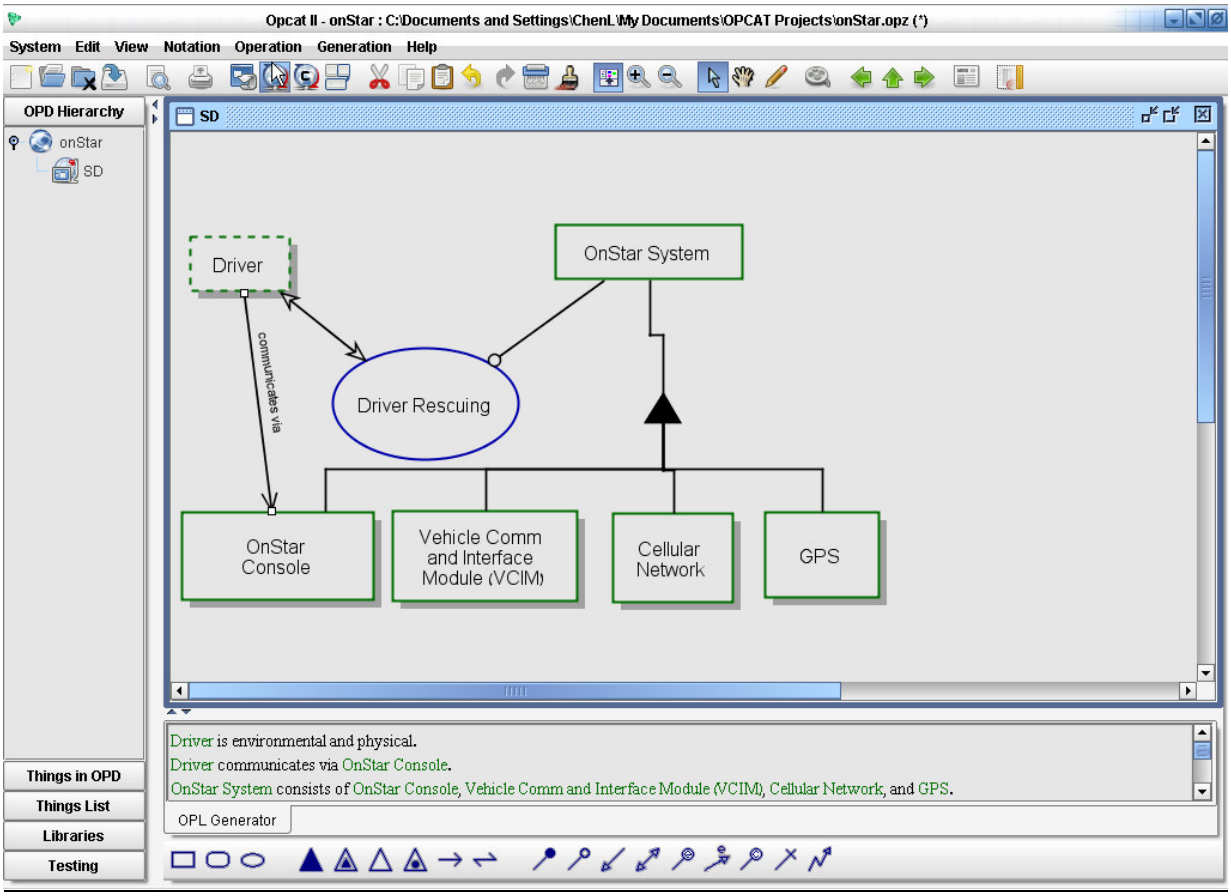


Figure 19. Specifying that Driver communicates via OnStar Console

In order to specify that Driver communicates via OnStar Console, we click on the unidirectional tagged structural link, the fifth button in the middle, structural links group, and drag it from Driver to OnStar Console. The result (without the label along the link) is shown in

Figure 19.

Inspecting the newly generated OPL sentence we see that it reads as follows:

Driver relates to OnStar Console.

Since we wish to be more specific, we double click the link we just drew and get the dialog box in

Figure 20.

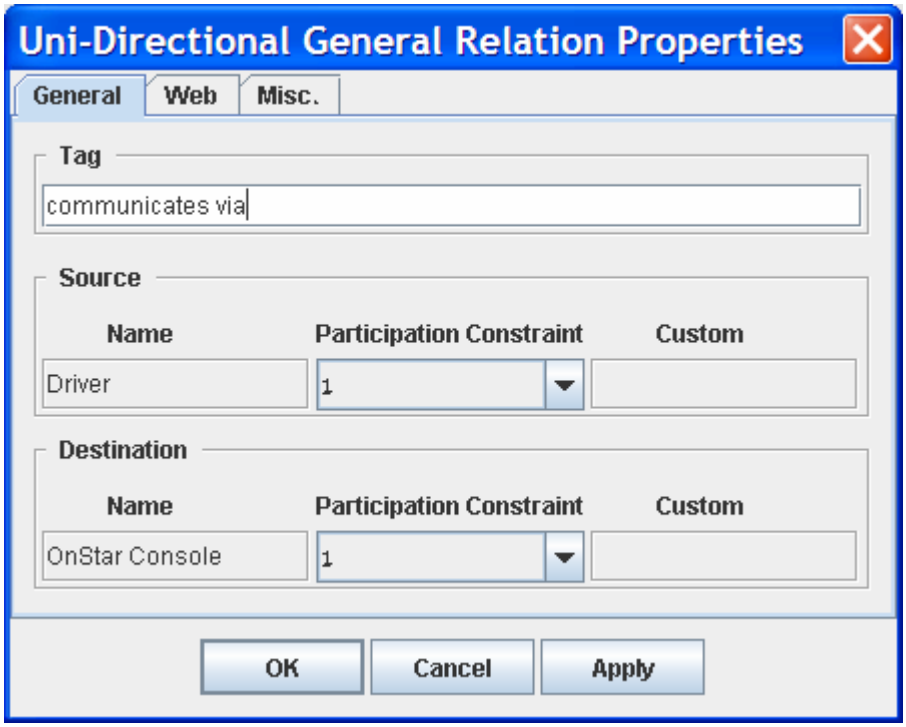


Figure 20. Inserting the tag "communicates via" in the unidirectional general structural relation

We type "communicates via" in the Tag box, click OK, and the OPL sentence now changes to:

Driver communicates via OnStar Console.

This OPL sentence appears at the last line in Figure *19*.

Tagged Structural Links will be used to provide additional information about the system that can not be expressed by using any of the other structural links.

5. Zooming into the main process

At this point the System Diagram, SD, is already quite crowded, but we barely scratched the surface of specifying the OnStar System. How are we going to keep on modeling while maintaining the OPD clear and readable?

To the rescue comes the OPM built-in in-zooming mechanism. In-zooming is a refinement mechanism. It enables starting a new Object-process Diagram (OPD), in which a thing (process or object) is copied from the ancestor OPD, and it is blown-up in order to enable specifying its sub processes.

Along with the in-zoomed thing, things that were attached to it (directly or indirectly) are brought along so as to maintain the consistency across the entire OPD set.

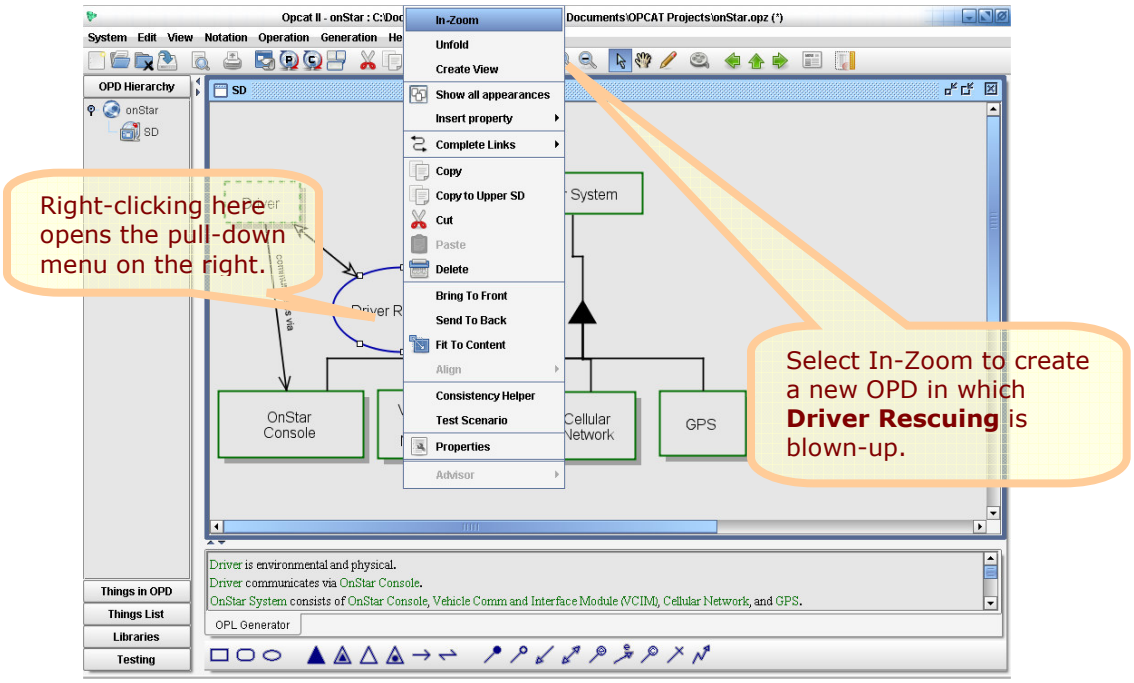


Figure 21. Zooming into the Driver Rescuing process

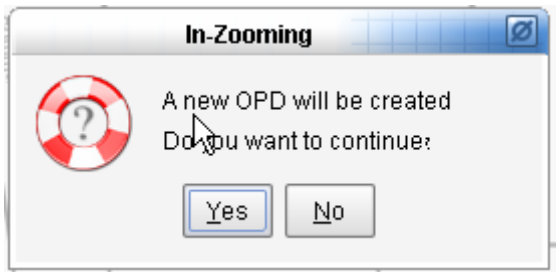


Figure 22. Zooming into the Driver Rescuing process

As we seen above we first selected the main function of our system, Driver Rescuing, and described the main necessary objects and the main result or effect of this process. Now we will continue to refine the specification of the system using the processes as the skeleton for decomposition.

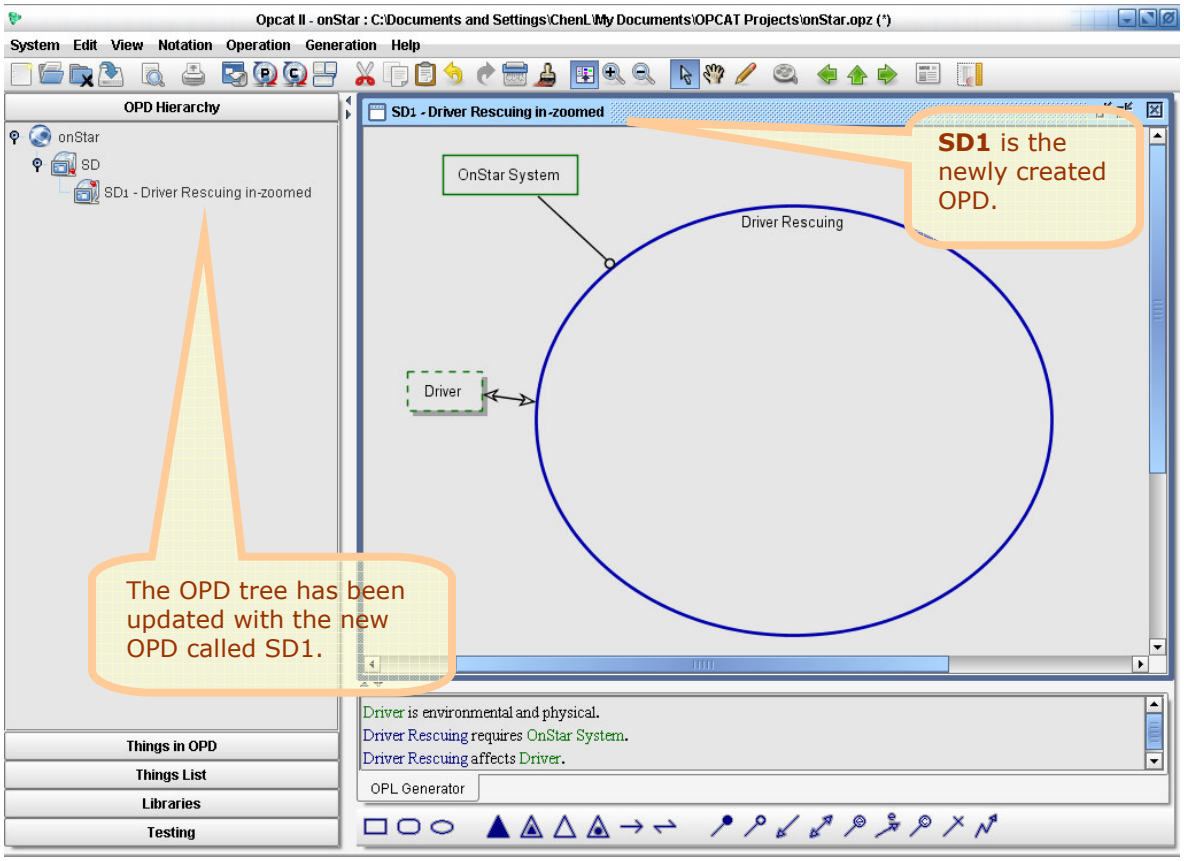


Figure 23. The new OPD titled SD1 – Driver Rescuing in-zoomed, created after zooming into the Driver Rescuing process

Following the "5 Plus or minus 2" law, we will continue to refine the system's specification by adding between 3 to 6 nested subprocesses, which, in turn can be further in-zoomed into new 3 to 6 subprocesses. We continue this until we are satisfied with the level of detail of t he system.

SD1 should hence describe the 3 to 6 main subprocesses comprising the Driver Rescuing process by the OnStar system.

For each process we will describe the preconditions and the result or effect. We will do this by adding objects or states to objects, to the level of detail required i to describe the preconditions and results of the nested subprocesses. More details about these additional

objects can possibly be added when we zoom into the sub-subprocesses of each subprocess.

Remember that OPM uses detail decomposition, i.e., the lower levels are merely a detailed description of the upper levels. Consistency must be maintained between any two OPDs related by a father-son relationship, so that overall the entire OPD set is consistent. For additional explanation about this topic, please review the Advanced Course Package.

To make a call in the OnStar system, you say out-loud a phone number or a previously stored name associated with a phone number. Modeling this statement presents us with an opportunity to recommend an effective OPCAT design methodology.

The first subprocess of Driver Rescuing is Call Making. In Figure 24 we add this subprocess within and at the top of the enclosing Driver Rescuing process.

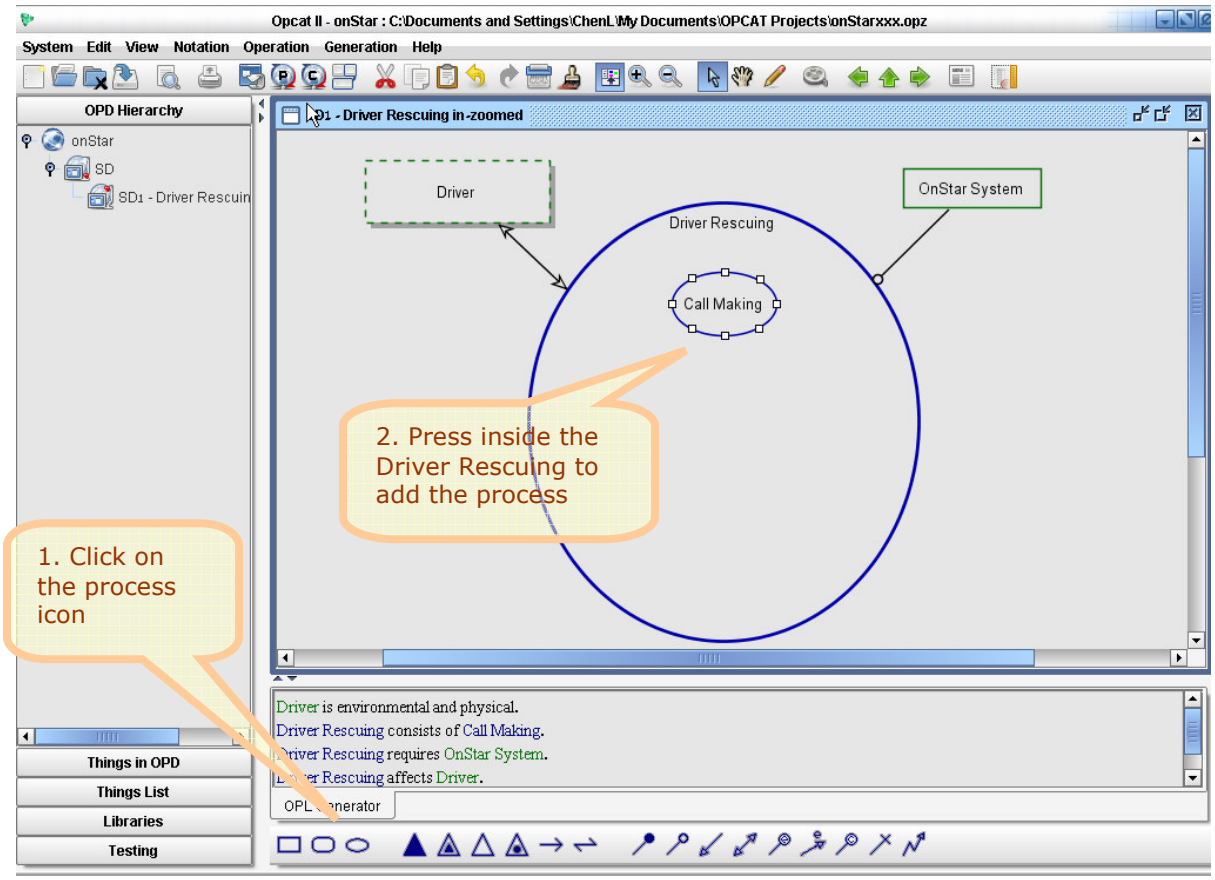


Figure 24. Call Making is inserted as the first subprocess within the in-zoomed Driver Rescuing process.

Call making requires the driver and the OnStar Console. In order to express this we need to bring OnStar Console to this OPD. Since OnStar Console is already connected to the OnStar System elsewhere we can use the Insert Property feature to facilitate this action.

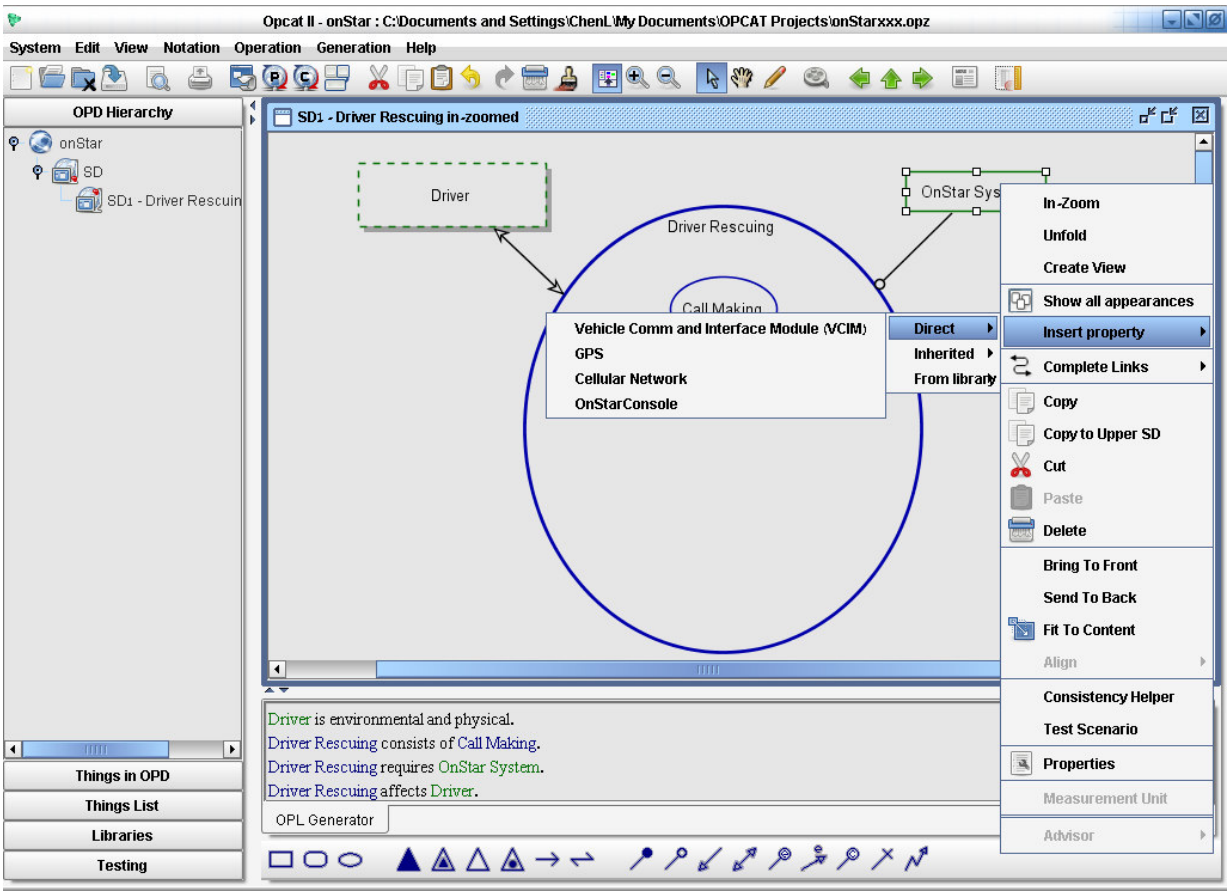


Figure 25. Adding OnStar Console by using the Insert Property feature

The Insert Property feature is available if the relationship is defined in other OPD or is inherited. It is also possible to insert structural relationship which is stated in the model repository. To learn more about this option please refer to the Advanced Course Package.

Now its time to state that the Driver and OnStar Console are required for Call Making.

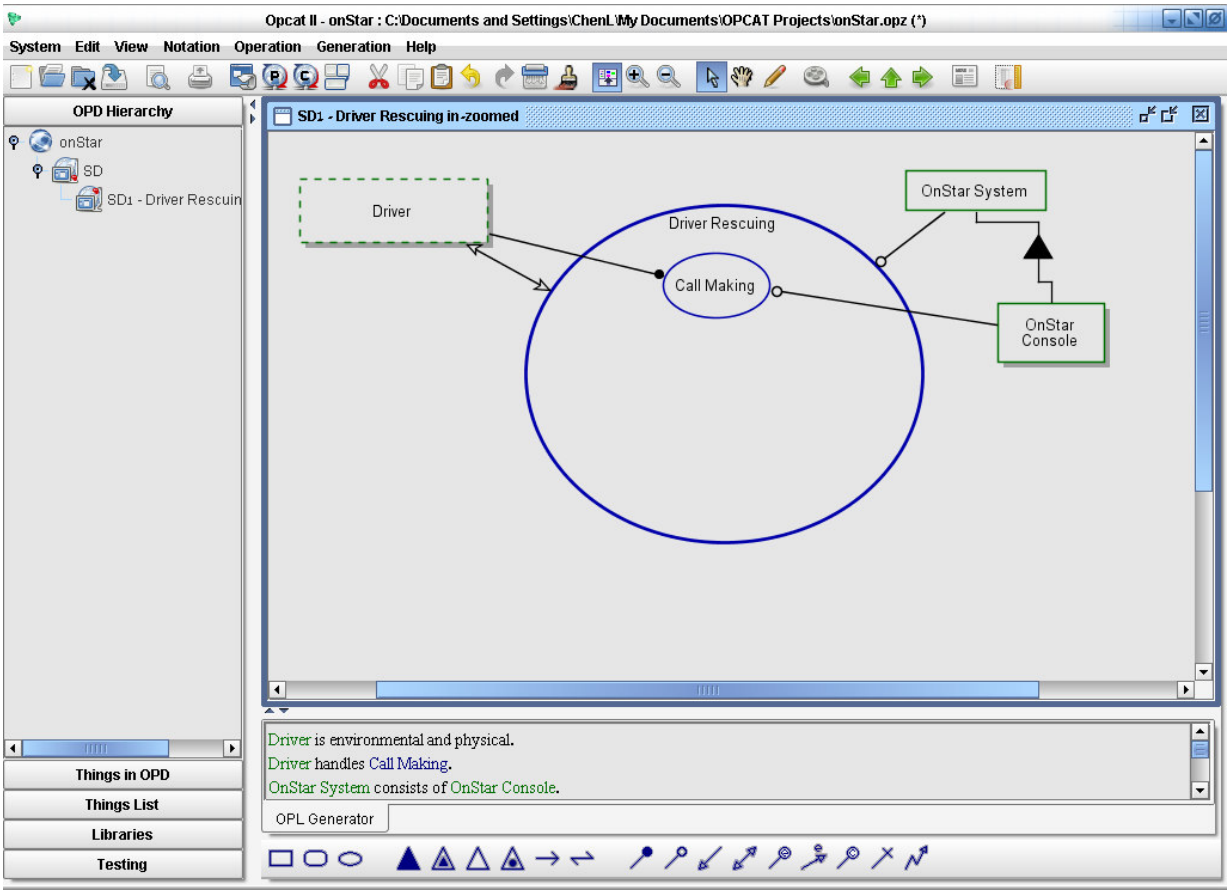


Figure 26. Connecting Call Making

OnStar Console is required for Call Making and therefore connected with an Instrument Link. Driver is also required for Call Making but is connected with Agent link. The Agent link denotes that Driver is a human required for the Call Making process.

Now we need to ask ourselves what is the result or effect of Call Making. In this case the result is a call.

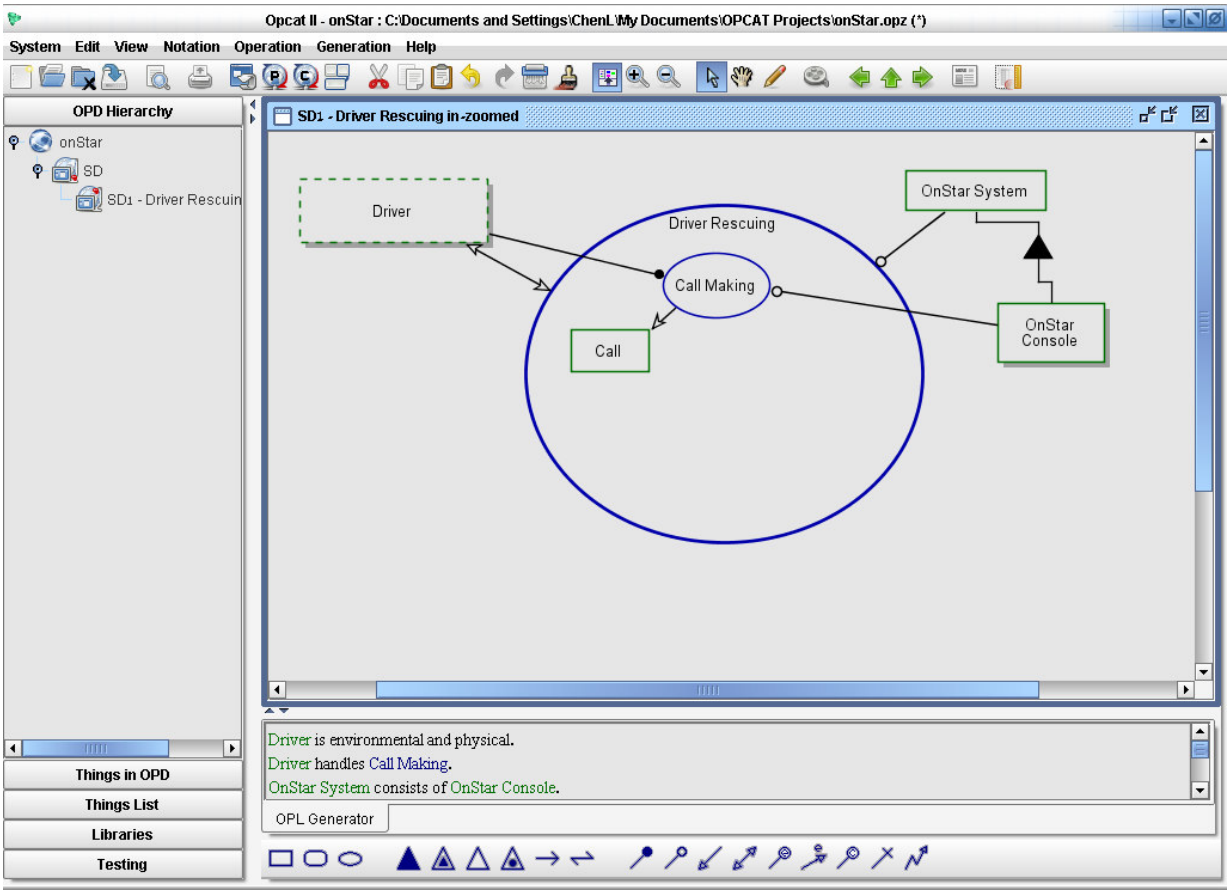


Figure 27. Call is generated as a result of Call Making.

The next process is Call Transmitting. Processes in OPCAT are happening from top down. If processes are happening in parallel they will be positioned in parallel. For design of asynchronous processes that are triggered without a pre-set time line, please refer to the Advanced Course Package.

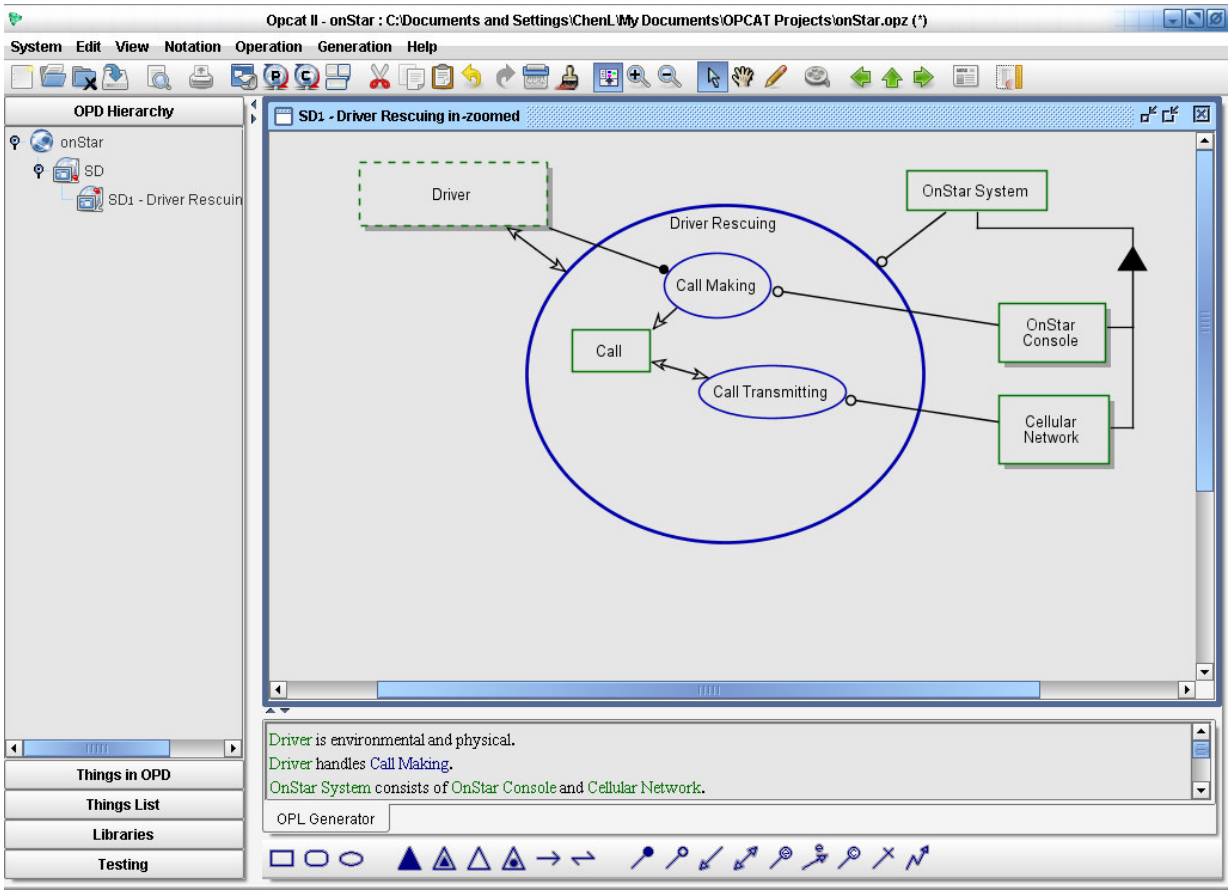


Figure 28. Call Transmitting preconditions

Call Transmitting is using the Cellular Network and affecting the Call. In order to add Cellular Network to SD1 we can use the Insert Property feature or cut & paste it from other OPD.

In Parallel the Vehicle Location Calculating is using the GPS to produce the Vehicle Location

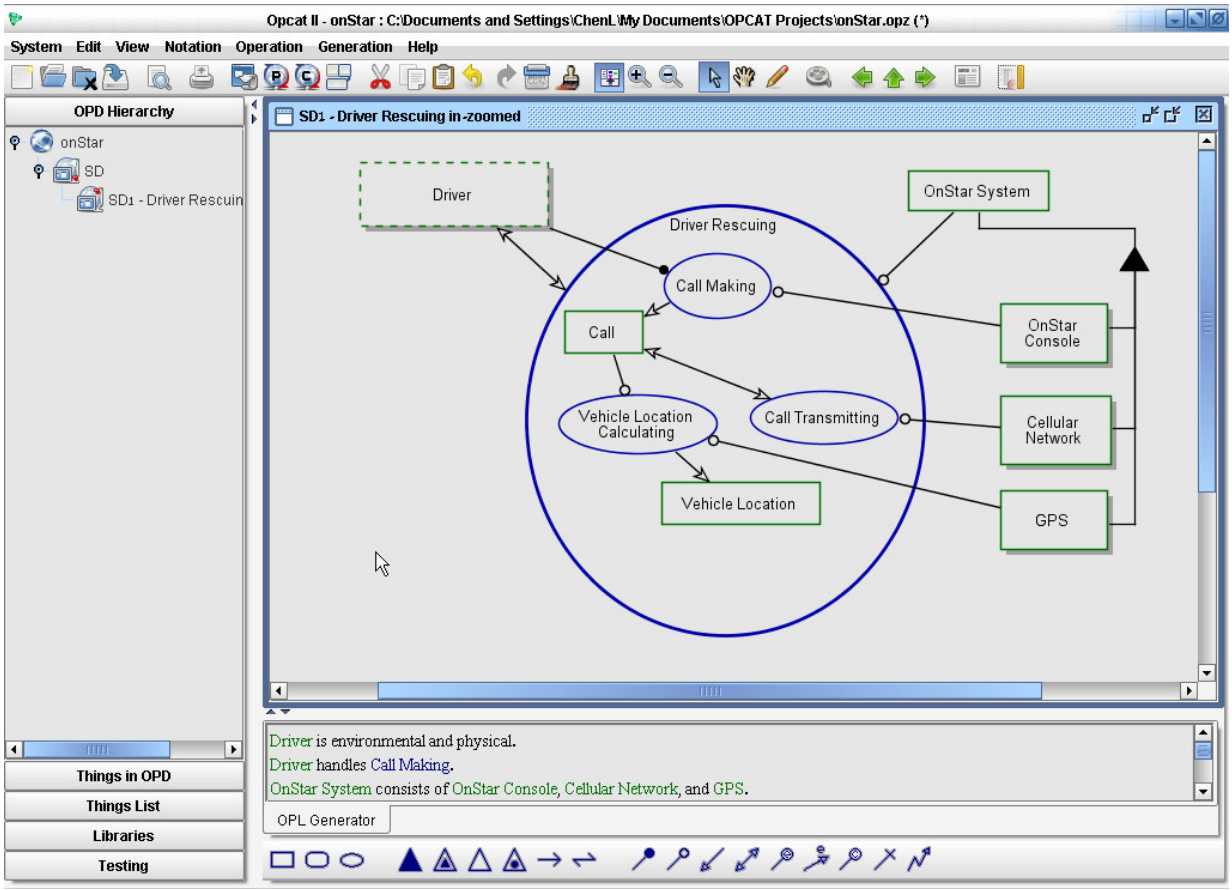


Figure 29. Adding Vehicle Location Calculating

Quick Summary

- We in-zoom into the main process and then describe the different sub-process
- The process activation order is from top down. Parallel processes will be positioned in parallel.
- Processes without a time line will be positioned outside the process. For more information about this please refer to the OPCAT Advanced Course lessons.
- In parallel we will describe the surrounding objects. Each process will be connected to the relevant process. Objects that are needed for all the internal processes can be connected with one link to the in zoomed process.

6. Basic Conditional Flow

As explained previously the Effect link between Call Transmitting and Call might be replaced in lowers OPD by a more detailed links. If we have decided to detail the type of the effect at this level the OPD may look like this:

Figure 30. Detailing Call states

Figure 30 shows how we can add states to Call and detailing the fact that Call Transmitting is changing Call from requested to online. This fact is also represented by the OPL.

Figure 31 express an alternative design in which Vehicle Location Calculating is occurring only when Call is online. Note the difference in the source of the instrument link between Figure 30 and 31.

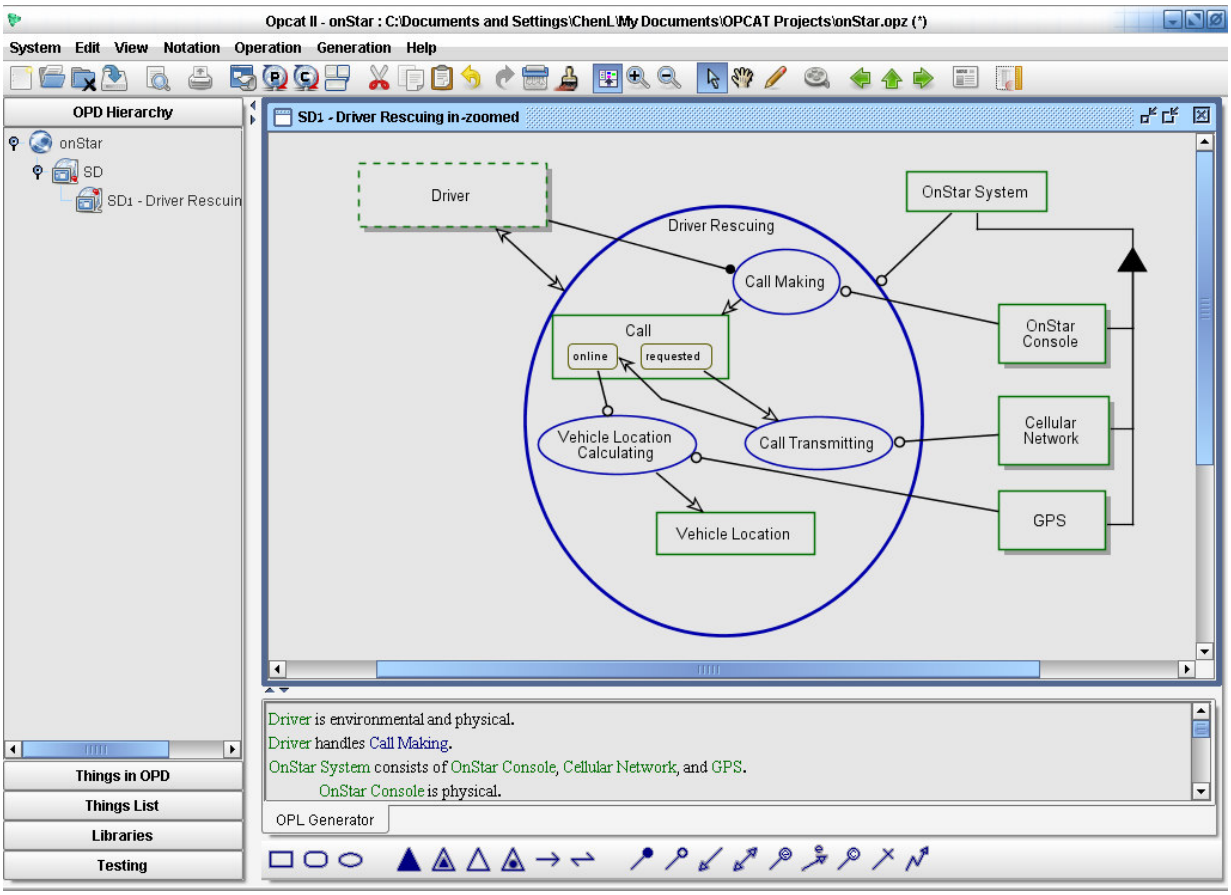


Figure 31. Conditional flow

Additional information about conditional flow can be found in the Advance Course Package.

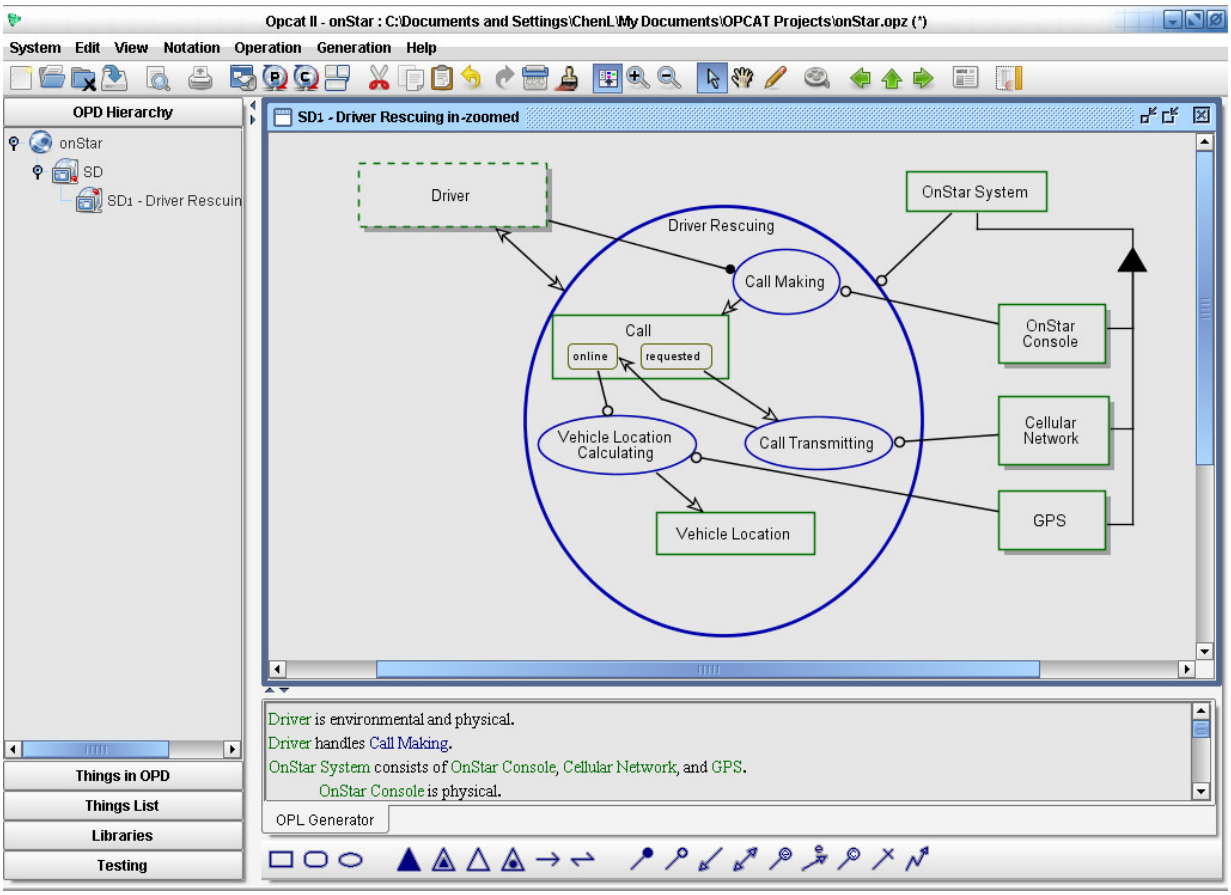


Figure 322. Conditional flow

7. Consistency

Let's now continue to the final process of Call Handling. According to the OnStar System description, at this stage an OnStar advisor handles the call. Lets add OnStar Advisor to our design.

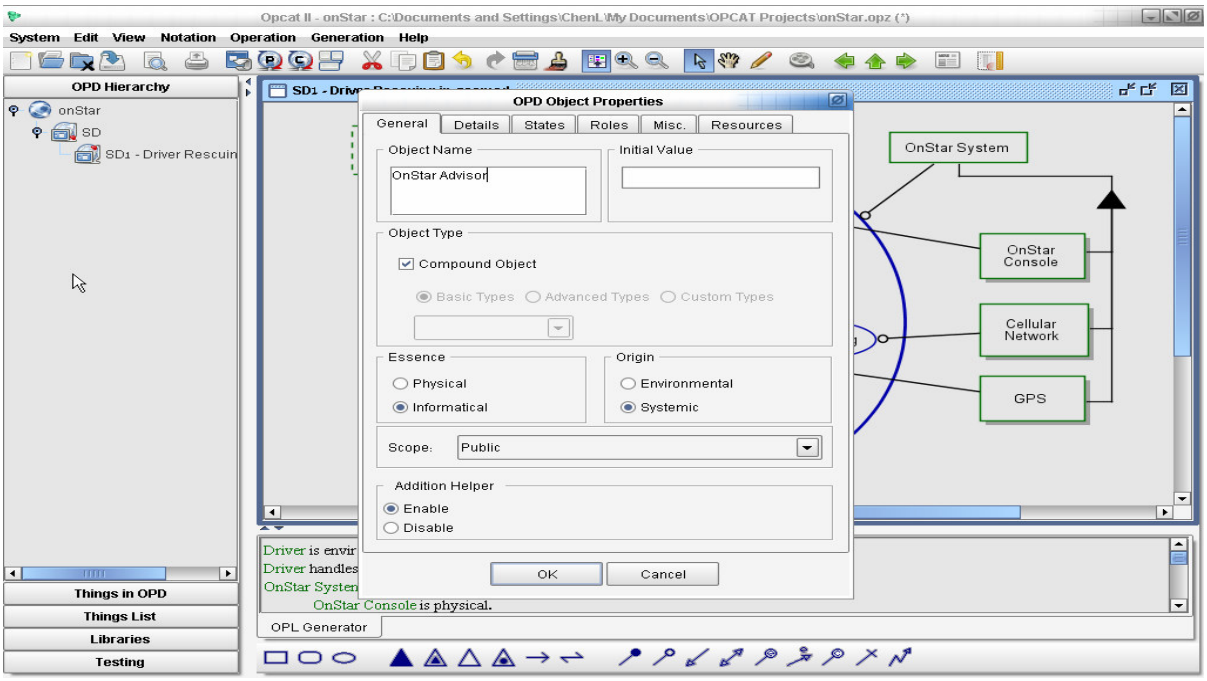


Figure 333. Adding the OnStar Advisor

Onstar Advisor is added outside the process, while Call was previously added inside the processes. The rule here is that any Object that is required only for the nested processes and does not exist when the process is not active will be positioned inside the process. Otherwise the object must be positioned outside the process.

As we already mentioned if we add a thing at a lower OPD it should be only detailing a thing that already exists on the upper level. In this case, is the OnStar Advisor part of the OnStar System or any other object at the upper level? In any case OPCAT drives our attention to the need for consistency by asking the following question:

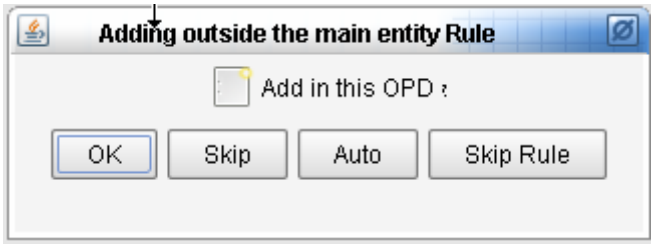


Figure 344. Consistency Rules

Selecting OK will add OnStar Advisor to the top OPD. Another question is whether the OnStar Advisor is part of the system. If not, we will mark the OnStar Advisor as Environmental.

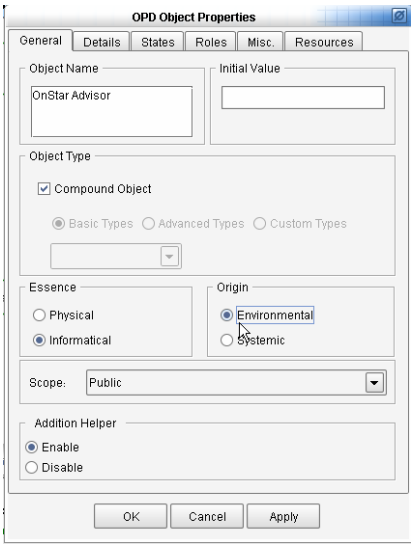


Figure 355. OnStar Advisor Properties

We will now connect the OnStar Advisor with an Agent Link. At SD the OnStar Advisor will be connected to the Driver Rescuing Process. At SD1 we will detail to which specific process the Onstar Advisor is required and therefore connect the Agent link to Call Handling process.

In addition, in order for call handling to happen we need the Driver, the Vehicle Location.

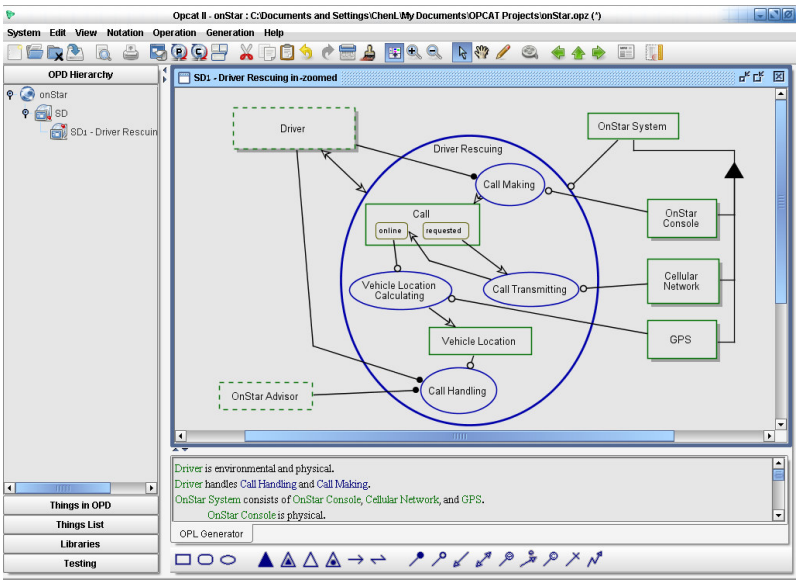


Figure 36. Call Handling Preconditions

Eventually, the Call Handling Process is changing the Drivers Danger Status from in danger to safe. Danger Status is and attribute of the Driver.

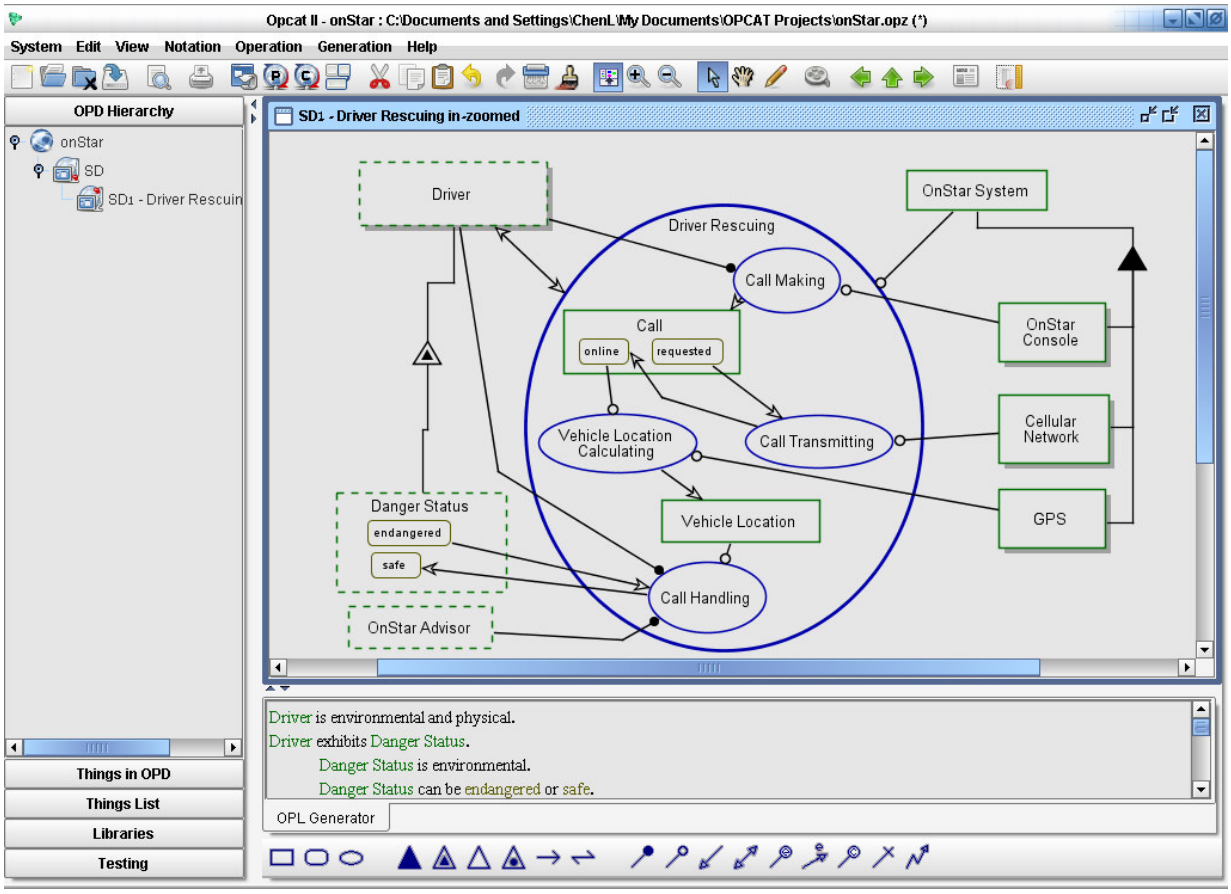


Figure 37. Call Handling results

8. Marking Initial States

At this stage we may want to emphasis the fact that when the system starts to operate the Danger Status is in the state endangered. We may also want to say that the object call is created by the process Call Making in the state of requested. We can do this by marking those states as "initial".

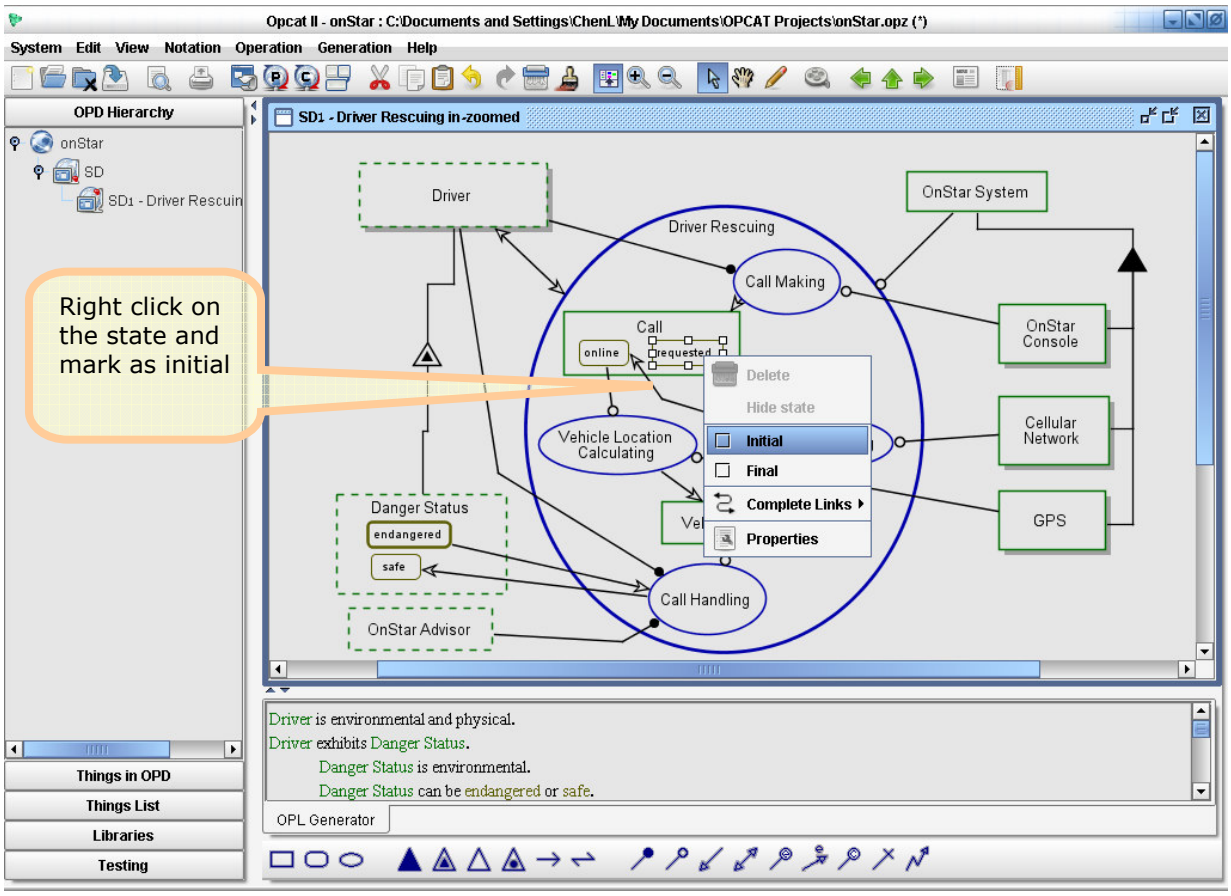


Figure 38. Marking initial states

9. In-zooming into the next level

At this stage when our Driver is finally safe we can continue and go into the details of each of the sub-processes.

When in-zooming into more details we must remember that each OPD draw the borders for the lower OPDs. For instance Call Making is using OnStar Console and the Driver and yields a Call. At the next level we might describe the different parts of the OnStar Console, user interface, authentication processes and so on. Nevertheless, it will all be details of the Driver, Call Making or OnStar Console. If we have found that something is missing then it should be added to the upper OPD as well, as demonstrated above with regard to the OnStar Advisor. If you go back to the requirements described at the beginning of this guide you will see that there is a possibility of automatic Call Making by using a "small panel located in the rearview mirror". If this panel is part of the OnStar Console it will be described at the next level. If not it should be added to SD1 and marked as instrument to Call Making.

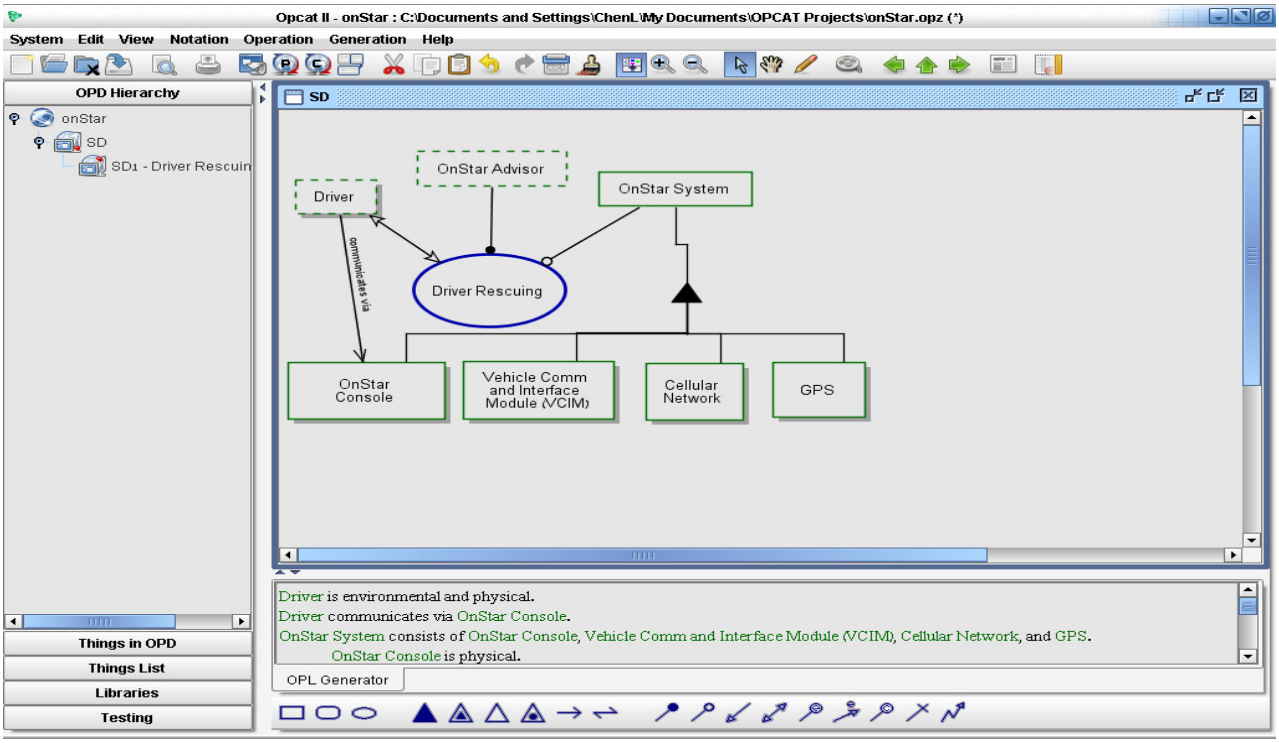


Figure 398. returning to top level OPD

It may be also a good time to revisit the upper OPD and decide whether we need this level of details at the top level. We may decide for example that the parts of the OnStar System will be described only at the lower levels.

10. Summary

This guide is providing you the basic concepts of OPM design. You are more than welcome to complete the design of the OnStar System according to the requirements stated at the beginning of this Guide.

In order to learn how to use the simulation, tagging, views creation, model repository and additional advanced topics you are invited to obtain the OPCAT Advanced Course Package by contacting us at consulting@opcat.com.

List of Diagrams

Annex A

OnStar System Specification

Being in a car accident, you push a button on a console and are instantly connected with an OnStar advisor. The advisor can pinpoint your exact location and relay your problem to emergency services. If you're in an accident, your car can "tell" OnStar without you having to do a thing.

Source: http://auto.howstuffworks.com/onstar.htm/printable

Cars equipped with OnStar have a small panel located in the rearview mirror, the dashboard or an overhead console, depending on the model. The blue OnStar button allows you to contact a live or virtual advisor. The red button with the cross on it is for emergencies, and the phone or "white dot" button allows you to make phone calls just as if you were using a cell phone.

At its most basic, OnStar consists of four different systems: cellular phone, voice recognition, GPS and vehicle telemetry. All of the services that OnStar provides are a result of one or more of these systems working together, making it a ""System of Systems".

OnStar's cellular service is voice-activated and hands-free. The console contains a built-in microphone and uses the car speakers. To make a call, you speak a phone number or a previously stored name associated with a phone number. The console is connected to a Vehicle Comm and Interface Module (VCIM), which uses a cellular antenna on top of the car to transmit signals to OnStar's cellular network.

For calls to the advisor, OnStar uses voice recognition software. OnStar can "surf the Web" using the Virtual Advisor automated system. For this service, OnStar uses text-to-voice technology called VoiceXML. When you ask for information, such as "weather," the software translates your request into XML (Extensible Markup Language) and matches it to settings in your OnStar profile. Then it translates the information into VoiceXML and reads it to you.

The GPS receiver is called OnCore, and it is part of the VCIM. A GPS receiver in the vehicle picks up signals form GPS satellites and calculates the location of the vehicle. The OnStar Call Center uses four different satellites to pinpoint the car's location when either the driver or the car itself asks to be located. That location is stored in the vehicle's OnStar hardware. The GPS uses the amount of time that it takes for a radio signal to get from satellites to a specific location to calculate distance.

When the driver pushes the blue OnStar button or red emergency button or an airbag deploys, OnStar places an embedded cellular call the OnStar Center with the vehicle location data. An OnStar advisor handles the call.

To give a vehicle the ability to call when it is in an accident, OnStar uses an event data recorder (also known as a crash data recorder). GM calls the entire process the Advanced Automatic Crash Notification System (AACN). The AACN system comprises four components: sensors, the Sensing Diagnostic Module (which includes the event data recorder), the VCIM and the cellular antenna. When the car is in a crash, sensors transmit information to the Sensing Diagnostic Module (SDM). The SDM also includes an accelerometer, which measures the severity of the crash based on gravitational force. The SDM sends this information to the VCIM, which uses the cellular antenna to send a message to the OnStar Call Center. When an advisor receives the call, he uses the GPS to find the vehicle's location and calls the car to check with the driver. Even if there's not a measurable impact, the VCIM also sends a message when the air bag goes off, prompting the advisor to call the car's driver.