The Swedish Traffic Conflict Technique

observer's manual

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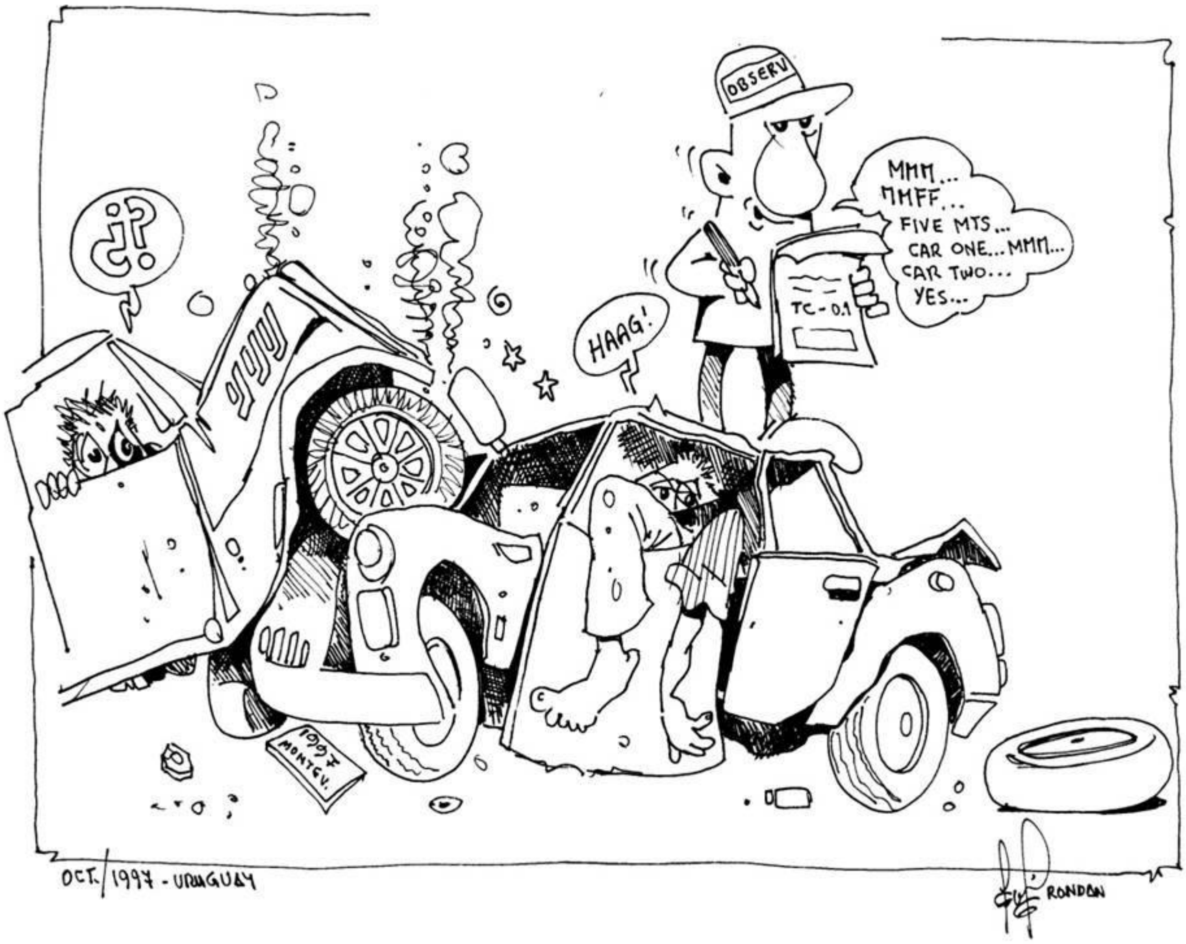

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1 Introduction

Traditionally, road safety is described in terms of number of accidents or injuries that occur in traffic. While such indicators have the most direct connection with the subject studied, they have a number of serious limitations:

- Traffic accidents are random events and the number of accidents registered every year at the same place is not the same, even if the traffic situation is unchanged. From this perspective, the actual accident number is also an indirect measure, while the true safety characteristic is the "expected number of accidents" that cannot be measured but only estimated based on the accident history or using some other methods (Hauer, 1997).
- Traffic accidents are rare events and it takes a long time to collect a sufficient amount of accidents data to produce reliable estimates of the expected number of accidents. During that time the traffic conditions might (and usually do) change (Hauer, 2015). There is also an ethical problem in that one has to wait for sufficient number of accidents to occur and thus for people to suffer before anything can be said about the (un-)safety.
- Not all accidents are reported. The level of underreporting depends on the accidents severity and types of road users involved. This is particularly a problem for the vulnerable road users (Elvik et al., 2009; Amoros et al., 2006; Alsop & Langley, 2001).
- The actual process of the accidents is often unclear since only the final accident outcome can be observed during the registration phase. Accident reconstructions and in-depths investigations are usually costly and not always possible to perform; doing it with a help of witnesses and those involved in the accidents presents a great risk of bias. Without information about the process preceding the accident it is very difficult to understand the link between (contributing) behaviour and accident which limits the possibilities to propose effective counter-measures in order to change/reduce this behaviour.

For these reason there is an interest to use some other, indirect measures for assessing traffic safety (also called surrogate safety measures). 'Indirect' in this context means measures not based on accidents, but rather on other occurrences in traffic that are causally related to accidents or injuries, can indicate safety performance and help to understand the process that leads to accidents.

This manual explains how to use the Swedish Traffic Conflict Technique (Swedish TCT) - one of the oldest, well-tested and well-validated surrogate safety tools that is still in active use by road safety practitioners.

2 A historical flashback

The first practical application of a traffic conflict technique was done in the late 1960s by a team of researchers at General Motors Corporation (*Perkins & Harris*, *1967*), but the idea was "in the air" at least a decade earlier (*Forbes*, *1957*). After the success of the first attempts, the method rapidly gained popularity. In 1977, the ICTCT (International Co-operation in Traffic Conflict Techniques, *ICTCT*, *2016*) association was grounded which became an important forum for researchers working in this area of traffic safety.

At the first ICTCT workshop in Oslo, the following definition of the traffic conflict was suggested (*Amundsen & Hyden*, *1977*):

> *A traffic conflict is an observable situation in which two or more road users approach each other in space and time to such an extent that there is a risk of collision if their movements remain unchanged".*

After the early 1990s, the use of traffic conflict techniques became less frequent. The most important reason was the significant costs in time and efforts since most of the data collection had to be done by human observers. However, new technologies such as advanced automated video analysis revive the interest to the method. The use of traffic conflicts becomes particularly motivated as road safety improvements in most Western countries make it more and more difficult to rely on registered accident data only.

The Swedish TCT was developed at Lund University in 1970s. It has been modified a few times since the first version was presented. The following basics have, however, remained the same:

- the requirement for a collision course in a conflict;
- the definition of conflict severity based on the onset of an evasive action;
- the distinction between serious and non-serious conflicts. The serious conflicts were found to be an indicator of a breakdown in the interaction – similar to a breakdown preceding an accident.

More about the evolution of the Swedish Traffic Conflict Technique can be read in the literature suggested in Chapter 11.

3 Theoretical grounds of the Swedish TCT

The safety pyramid and continuity of the events

The basic concept that the traffic conflicts theory is based on is that the traffic process can be seen as a number of elementary events. These events differ in their degree of severity (unsafety) and there exists some relation between the severity and frequency of events of that severity. *Hydén (1987)* illustrated the concept with a 'safety pyramid' (see Figure 1). The lower part of the pyramid represents the normal interactions (encounters) between road users that are safe and occur most of the time. At the other extreme, the top of the pyramid consists of the most severe events such as fatal or injury accidents and that are very infrequent compared to the total number of the events. If the form of the relation between the severity and frequency of the events is known, it is theoretically possible to calculate the frequency of the very severe but infrequent events (accidents) based on known frequency of the less severe, but more easily observable events (conflicts).

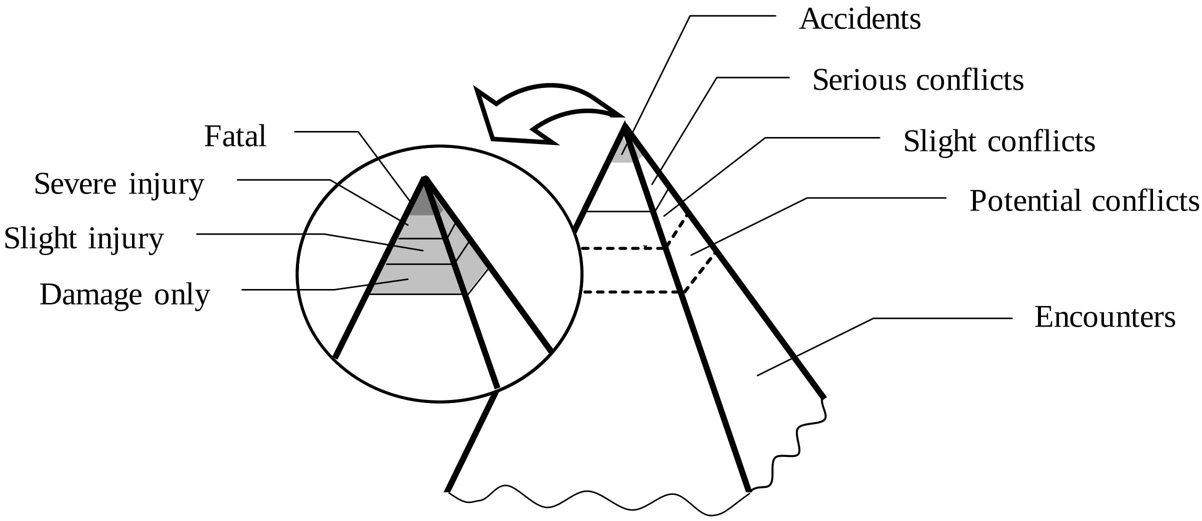


Figure 1. "Safety pyramid" (adopted from Hydén, 1987).

The concept of severity

The proximity to a collision is only one dimension of "severity". The potential consequences in case a collision had taken place is another aspect that should be taken into account. For example, minor collisions between cars at parking lots are hardly any concern for road safety, as they almost never result in any injuries for car occupants. On the other hand, a near-miss between a cyclist and a heavy truck moving at high speed would be perceived as a very severe situation as, had it become a collision, the consequences would be very dramatic.

Ideally, the appropriate theoretical definition of severity should be "a nearness to a serious personal injury" which is very much in line with the Vision Zero philosophy - "no one will be killed or seriously injured within the road transport system" (*Johansson, 2009*). However, it is not obvious how the injury risk in situations where the collision was actually avoided can be estimated. The most common practices therefore are either to ignore the potential consequences or to use some subjective rules on how they can be integrated into the final severity score.

The Swedish TCT includes the speed at which the conflict occurs in the final grading of conflict severity which, at least partly, takes into account the severity of the potential consequences.

Reliability and validity

Reliability of a measuring tool is the property to keep the same accuracy regardless to conditions in which it is used. Applied to traffic conflict studies, reliability means that the method for conflict detection and severity scoring should guarantee that the differences in conflict counts can be attributed to differences in safety and not to loss attention by the observer, weather or lighting conditions, etc.

The traditional traffic conflict techniques have been criticised for using human observers as the main "measuring tool". The ability of the observers to stay alert during longer time periods and estimate indicators like Time-to-Collision (TTC) objectively was questioned. A number of calibration studies (*Hydén*, *1987; Lightburn & Howarth*, *1979*) proved that it is possible to train observers for consistent detection of conflicts and judgment of speeds and distances. It is important, however, that the observers are trained in a similar manner and that the training is refreshed periodically, as the skills tend to deteriorate with time.

In recent years, the objective tools like video analysis have become more common for traffic conflict studies. Objective per definition, their accuracy is still dependent on the quality of the cameras used, their calibration, partly on the traffic conditions and weather. However, the rapid progress in this field gives hope that the reliability of these tools will not be an issue in the near future.

Validity is a more fundamental property characterising the ability of a traffic conflict method to reflect the quality of interest, in our case road safety. Since many different operational definitions of conflicts have been suggested, one can wonder whether some are more valid than the others. Unfortunately, the validation studies that relate the observed conflicts with actual accidents at the same site are very few.

In this respect, the Swedish TCT is very unique as it is based on several large-scale validation studies (see further reading suggestions in Chapter 11).

4 Fundamental definitions of the Swedish TCT

According to the Swedish TCT, a **collision course** is a necessary condition for a conflict. Collision course implies that, unless one of the road users takes an evasive action, a collision will happen.

The severity of a conflict is defined at the moment when one of the road users start taking an evasive action. The road user who took an evasive action first is called the **relevant road user**.

The conflict severity is based on two indicators:

- **Time-to-Accident (TA)** - time remaining to a collision when the evasive action is taken by the relevant road user;
- **Conflicting Speed (CS) -** speed of the relevant road user when he/she takes the evasive action.

TA describes the time remaining for the road users to successfully perform an evasive action. Lower TA values indicates that the conflict is nearer to a collision and thus is more severe. CS affects both the chances to successfully avoiding a collision (e.g. braking from a higher speed would require longer time and stopping distance), but also the potential outcomes of the collision (e.g. injuries of a hit pedestrian would depend on the impact speed). Thus, higher CS values would indicate a more severe conflict.

Based on the TA and CS, the diagram in Figure 2 is used to define the severity level of the conflict. If the road users take evasive actions simultaneously, TA and CS are estimated for both of them. The relevant road user in this case is defined as the one who sets the **lowest** severity which is also the final severity level of the conflict.

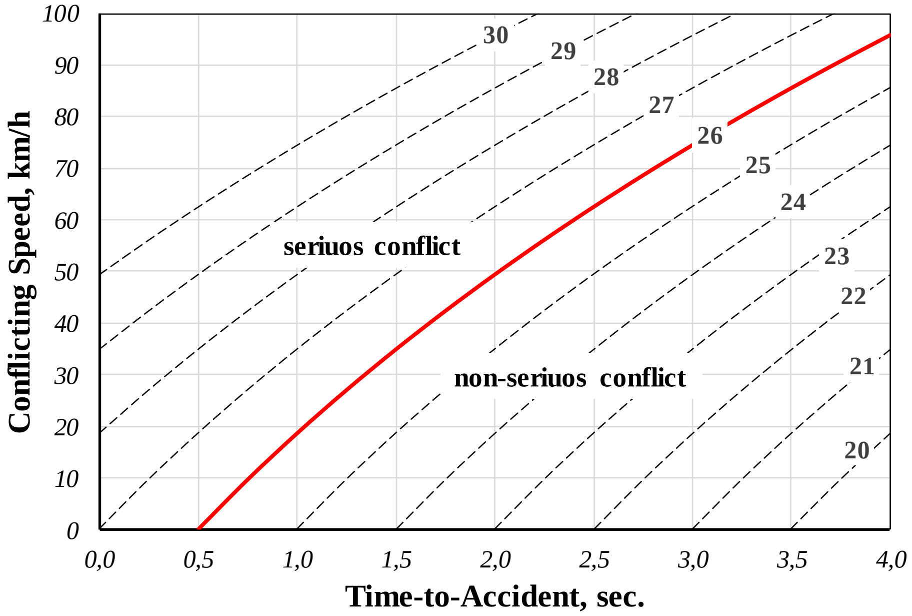


Figure 2. Conflict severity diagram.

Conflicts with severity level **above 26** (red line on the graph) are ranked as **serious**. It has been shown that serious conflicts have a strong statistical relation with police-reported accidents and even can be converted into expected number of accidents with a reasonable accuracy (*Svensson, 1992*).

In practice, it is easier to estimate the distance from the road user to the collision point rather than the time remaining to the collision. The conversion table in ***Appendix 2*** can then be used to calculate TA based on the distance to the collision point and the speed of the road user.

5 Advantages and disadvantages of using the Swedish TCT

Traffic conflict studies have the following advantages:

- Traffic conflicts are much more frequent compared to accidents. Thus, instead of waiting for years to get accident records, the data can be collected during much shorter time.
- Traffic conflicts are actually observed and thus much more information becomes available compared to what can be read in accident reports.
- Traffic conflicts studies are pro-active, meaning that the safety problem can be detected and addressed BEFORE the actual accidents occur.

The disadvantages/limitations of the traffic conflict studies are:

- The method requires trained personal, equipment for video recording and tools for video processing.
- Collection of conflict data requires work in field or processing of video to identify conflicts, while accident records are "already there" seen from a practitioner perspective.
- The relation between accidents and conflicts is not always clear for all types of conflicts. Conversion of observed conflicts into expected number of accidents is not very accurate.
- Traffic conflict studies are primarily made during daytime and in good weather conditions. However, use of video recording and automated tools for conflict detection, this restriction becomes less important.

For best results, it is advisable to combine traffic conflict observations with other methods such as accident analyses, behavioural observations and interviews with road users.

6 When to conduct traffic conflict observations

Traffic conflict observations is the right method if the goals are:

- to make a safety diagnosis of a site;
- to investigate the factors that contribute to accident risk at a certain site;
- to compare safety performance of different road infrastructure features, regulations and rules;
- to quickly evaluate the effects of road safety measures in before-after investigations;
- to monitor the development of the traffic safety situation of a site.

Similarly to accident analysis, mapping of traffic conflicts can indicate **where** accidents might be expected. Analysis of the conflict manoeuvres and road users involved can indicate **what types** of accidents to be expected. Watching the recordings of traffic conflicts, one understands the **process** of accident development, **contributing factors** and also gets inspiration for **possible countermeasures**.

Traffic conflict observations have been mainly used in urban areas. For rural roads, the available practical knowledge on method performance is more limited. This does not mean that the method cannot be used in rural areas, but it is advisable to plan the study and interpret the results with additional caution.

7 How to conduct a traffic conflict study

7.1 Manual traffic conflict observations

The advantage of manual conflict observations is the minimal required equipment and thus high flexibility in when and where to perform the study. What is needed are register forms, a watch and a pencil. However, this puts very high responsibility on the observer since it is the observer who has to detect conflicts, judge them and make notes, all in real time. It is becoming more and more common to use video recording parallel to the observations so that the observer can go back and see the situations once again when summarising the results. The issues related to use of video recordings are discussed in later sections.

Observation period

The number of observation days and number of observation periods per day is determined based on the expected frequency of conflicts. The expected frequency of conflicts is usually derived from previous experiences. For example, *Hydén & Várhelyi (2000)* concluded that 30 hours of observations at one site produce sufficient amount of serious conflicts to allow for a safety analysis of the site. More recent studies (*Laureshyn et al., 2017*) report that 75-80 hours of day-time observations is barely enough and suggest that the observation periods should be increased even further. This is explained by significant improvements of the safety situation in developed countries during last decades, thus lower accident risk is also reflected with lower conflict frequency. In countries with major road safety problems shorter observation periods can be used as the number of conflicts per time unit is still relatively high there (see e.g. *Abdul Manan & Várhelyi, 2015*).

Observations are usually done in periods of 1-2 hours with breaks in between for the observer to recover. If it is important to cover a longer continuous period, observers can alternate at the site.

The observation period should be of the prescribed length and start exactly on time. When the period starts, the observer should be 100% ready – the camera installed, the clocks synchronised, observation sheets at hands, etc. Therefore, it is recommended to arrive at the site at least 10 minutes before the start of the actual observations.

In before/after studies, the observation periods should be the same. It is also of importance that the before and the after observations are carried out during periods of similar traffic conditions (considering school or climate periods). The after observations should not be carried out directly after the implementation of a measure; experience shows, that it may take up to 6 months for the road users to adapt to the changed traffic conditions (*Hydén & Várhelyi, 2000*).

Observations are carried out in most cases in daylight and under dry weather conditions (this is due to hardship for human observers). If the accident pattern at the site is time-related, observations should take place during the periods when safety problems are most likely can be observed. Observations should not be carried out under unusual conditions, for example when large events in the vicinity interferes with “normal” traffic patterns.

Observers

The tasks of the observer are:

- to detect the conflict;
- to note who and when took the evasive action;
- to estimate the road users’ speeds and the distances to the projected collision point;
- to make a sketch of the conflict;
- to fill in other relevant information together with a verbal description of the course of events.

Observers are the most important "tool" in manual traffic conflict studies, therefore their proper training is highly important and should not be rushed or saved on. The training course for observers in Swedish Traffic Conflict Technique takes one full week and includes theoretical lectures, practical instructions, training on video-recorded conflicts, real-life field observation sessions and calibration of the observers.

The reliability of the observers is of fundamental importance for the valid results: the same observer should record conflicts consistently over time and the different observers should record the same conflicts in a similar manner. The trained observers need to stay in practice and should be "calibrated" against each other from time to time.

The number of necessary observers at one site depends on the complexity of the site. Experience shows that one observer can deal with a simple four-leg intersection with no more than two lanes per approach (up to an AADT of 22000 vehicles). Larger sites require an additional observer. When only one specific type of conflict is collected, one observer might be able to manage the task even at a complex site.

In case of an evaluation study, the observer should not have been involved in any way in the proposed countermeasure under evaluation.

In before/after studies, it is essential that it is the same observer who makes the observations in the before and the after situation.

Recommended equipment

The equipment of the observer usually includes:

- conflict register forms;
- A conversion table (to convert speed and distance to TA);
- a watch;
- a pencil (pencils usually perform better in rainy weather as they still can be used on slightly wet paper);
- a personal identification (from the organisation running the study);
- a video camera together with the equipment for mounting. The observer's watch should be harmonised with the camera clock before the start of the observations.

The conflict registering form

The conflict registering form contains some general information about the location, observer's name, observations date and time, weather and surface conditions (see ***Appendix 1***). For each conflict situation, the following information should be recorded:

- time of the event;
- road users involved;
- possible secondary road user(s);
- the speeds of the involved road users, their distances to the collision point;
- the calculated TA-value (from speed and the distance using the table in ***Appendix 2***)
- type of evasive action(s);
- a sketch of the conflict (including any possible secondary road users);
- verbal description of the course of events;
- notes of any possible violations of the traffic rules, hazardous behaviour or any other issues of interest.

Before the observations

Before conducting the actual observation, the following preparations are recommended:

- Collect relevant information about the actual site (a map and drawing of the site, accident history if available, type of regulation, signal settings, traffic volumes, etc.).
- Investigate possibilities for the camera installation. Balconies, lamp posts or other pieces of road infrastructure can be used.
- Print out a sufficient number of conflict registering sheets. A practical solution is to have a folder with pasted conversion tables on the on the left hand side and the conflict sheets on the right hand side.
- Check the weather forecast and take appropriate clothes.
- Have a phone number to the supervisor of the study in case of any inquires.

Carrying out the observations

After arriving at the observational site the observer should select an observational point offering a clear view over the observational area. The location of the observation point should be marked on the conflict register form together with an arrow, indicating the north direction. Alternatively, easy-to-find landmarks should be marked on the intersection sketch. This is extremely important for assigning correctly the directions of the involved road users and location of the conflict.

In before/after studies, the observational point should be the same.

The observer should be unobtrusive, i.e. his/her presence should not influence road users passing the site. For example, wearing a reflecting "yellow vest" is not recommended. However, it is important that the observer is not inside a vehicle or building, which could lead to loss of important information when "not breathing the same air" with the observed road users.

To facilitate estimation of distance and speed the observer should make some initial measurements at the first arrival at the scene (distance between salient objects or marks can be measured). Also, speed estimations with the help of a radar gun could be made to get a perception of the prevailing speeds at the site.

If more than one observer are working at the same site, they should clearly discuss and agree on which area each observer is in charge for. If a conflict occurs in a place where both observers might record it, a note should be done in a register sheet so that it can be checked afterwards to avoid double-counting.

Every detected conflict situation should be recorded on an individual register form. The form should be filled in as complete as possible immediately. To save time, some of the fields can be pre-filled in advance (e.g. location, observer's name and position, observation period, etc.). The conflict forms should be number to make sure that none of them been unintentionally lost.

All conflicts should be recorded, even if only the serious conflicts are used in the later analysis. When a conflict is first detected, it might not be obvious whether it is a serious conflict or not until the necessary indicators (TA, PET, etc.) have been calculated.

7.2 Video recording and video analysis tools

Why video recording?

To perform conflict observations in field is a difficult task. Detection of conflicts requires full attention at all times and, once a conflict has occurred, the observer has only one chance to see it and make all the necessary judgements.

Therefore, it is highly recommended to complement field observations with video recording at the same time. In this case, it is always possible to go back and watch the identified situations once again or ask a colleague for a second opinion. When reporting the results, the conflict observation sheets can be complemented with short video clips showing each conflict. This makes the study well-documented and transparent. The videos are very useful as an illustration of the safety problem for the decision makers or general public and they can also serve as a source of inspiration when thinking about possible safety counter-measures.

> **!** Do not forget to synchronise the time between your watch and the internal camera clock to make it easier to find the conflicts in the video recording later on.

It becomes more and more common that the actual conflict studies are done from the recorded video directly. This is more convenient as the observer can do the work indoors, "speed-up" the playback when traffic is low and nothing really happens, take breaks when necessary, etc. It is also possible to use special video processing tools that help to detect potential conflicts or measure speeds, distances, etc. from video with a higher accuracy.

However, it is important to realise that a video film does not fully represent the traffic environment due to limited area of view, a perspective that might be unusual for an observer, distortions in the view ('fish-eye'-effect), etc. It is, therefore, very important that the observer actually visits the site and spends some time there in order to understand how traffic is functioning and what is being left beyond the camera view.

> **!** Video recordings are considered personal data in many countries and thus there might be special rules that regulate whether the camera can be left recording autonomously, what resolution can be used, how the recording must be handled afterwards, etc. The rules differ a lot from country to country, therefore it is always a good idea to check the rules and get necessary permission before starting to record.

Recording equipment

For shorter recordings (for example during in-field conflict observations) a simple camcorder is a sufficient tool. However, if a longer recording is planned, several aspects should be considered:

- Sufficient storage space for the recorded video. It might be necessary to have a separate computer or a hard drive for data storage.
- Power supply. If no access to the power net is available, solutions with large capacity batteries (e.g. car batteries), solar cells or a field generator should be considered.
- Possibility for scheduling the recording, e.g. to exclude the night hours or weekends to save the data storage space.
- Protection of the equipment from the weather (rain, fog, low temperature) and theft/vandalism.
- Time synchronisation if several cameras are used to record the same location.
- Possibility to check the status of the equipment without visiting the site.

Another important aspect to consider is what type of camera (sensor) is most suitable. The most common sensor types are RGB (i.e. “normal” video), but thermal sensors are becoming more and more common and feasible pricewise.

Figure 3. Views of the same traffic scene taken simultaneously with an RGB and thermal camera.

The advantages and limitations of the two camera types can be summarised as follows:

RGB:	**Thermal:**
+ “Normal” view	~ “Unusual” view, though easy to interpret
+ Relatively low price	- Relatively expensive
+ High resolution	- Lower resolution compared to RGB
- Poor performance in dark conditions	+ Good performance during both light and dark conditions
- Moving shadows create difficulties for automated video processing tools	+ Shadows are not visible and thus create no problems
- Sensitive to direct sun light or sun reflection on asphalt, windows, etc.	- Problems in hot weather when asphalt gets warm
- Issues related to privacy protection	+ Personal data (faces, number plates) are not recognisable

Positioning of the camera

If the video is meant only to be a back-up for the observer in the field, the requirements for positioning of the camera are not very strict. It can be put on a tripod near the conflict observer or on street furniture at 2-3 meters height.

However, if at a later stage some computer tools for video processing will be used, the requirements are much more specific:

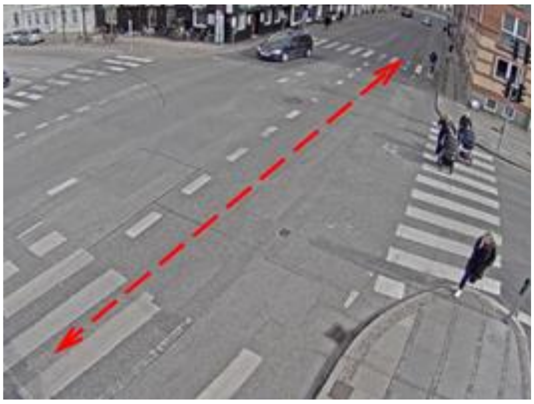
- The camera should be positioned as high and be directed as straight down as possible to get a “bird-eye view”. This is necessary to mitigate the problem of occlusion – situations when one road user is not visible behind another one. In practice, however, one have to compromise using lamp posts or balconies that are available. As a rule of a thumb, at least **7-8 meters height** is recommended.
- **No sky should be visible.** First, if the recording is done during longer period, the sun might move so that the light comes directly into the camera objective and nothing will

be seen (the image gets overexposed). Second, the sky in the view simply means that less part of the image is devoted to the “relevant content”.

- It is recommended that the area of interest in the camera view is aligned with the **image diagonal**. By doing so, the available resolution is used in the most efficient way.

Figure 4 provides some examples of camera views with comments.

High positioning of the camera (in this example, on a top of a building nearby, h≈40m) gives a perfect view over the studied location. In reality, however, it is a very big luck to get a view like that. Also, note how the trees are obstructing the view of the right leg of the intersection, limiting the possibility to observe interactions at the pedestrian crossing at that leg.



This view is taken from a camera mounted on a lamp post (h≈8m) and is the most common perspective to get. The entire intersection and particularly the approaches to it are not fully seen. It is therefore necessary to take a decision which parts of the intersection are of most interest and orient the camera to get the best view for this area. To use two cameras can also be an option to consider. Note, how the area of interest is oriented “diagonally”.

An example of a less successful camera perspective. The sky in the view creates a risk of blinding when sun gets low. Even though a very long section of the road is visible, it is hardly usable due to very small size of the objects far away and difficulties in estimating distances or speeds. A more preferable orientation of the camera is shown with the red rectangle.

The camera is installed right above the pedestrian crossing creating a very unusual view for an observer. Due to the fish-eye lens, relatively long section of the approach to the crossing is visible, but the distortion makes it difficult for an observer to judge the distances and speeds. However, such measurements are possible with a special measuring tools that take the distortion parameters into account.

Figure 4. Examples of successful and less successful camera views.

Semi-automated and fully-automated tools for traffic conflict observations

‘Semi-automated’ video processing means that some technical tool is used as an aid in detection and analysis of the traffic conflicts, but part of work is still done manually. These tools can be of great use in a conflict study by making the work more efficient, standardising the output and providing better accuracy of the measurements. However, all important decisions still must be taken by a human observer.

Fully-automated software rely on complex video processing algorithms that can detect, classify and track road users in video and utilise this data to find and classify traffic conflicts. Object recognition and tracking is a rapidly evolving area in computer vision science, but it is also a very hard problem to solve. One of the main challenges is to make the algorithms stable in performance. It is possible to fine-tune the parameters to get relatively good results during a short period when the conditions remain the same. However, conflict observations normally require analysis of long recordings (several days or possibly weeks), days and nights, sun and rain, peak and off-peak traffic, etc.

Even if the fully automated tools are available in the near future, it is still very important not to blindly trust on the analysis produced by a computer program. 'Human-in-the-loop' is an important component for understanding the safety problems. A program can only find things that it is programed to find. An open-minded human observer can react on any unusual situations that occur. Thus, it is highly recommended that an observer both spends some time watching the normal performance of a site and carefully looks through the situations that were judged as safety-relevant by the computer program.

8 Presentation and interpretation of the results

Presentation of the results of a conflict study includes usually:

- A sketch with location of the conflicts (see Figure 5);
- A summary table presenting the conflict counts by type of manoeuvre, road users involved (see Figure 6);
- A diagram displaying the conflict severity distribution (see Figure 7);
- Short video clips containing the recorded conflicts (if available).

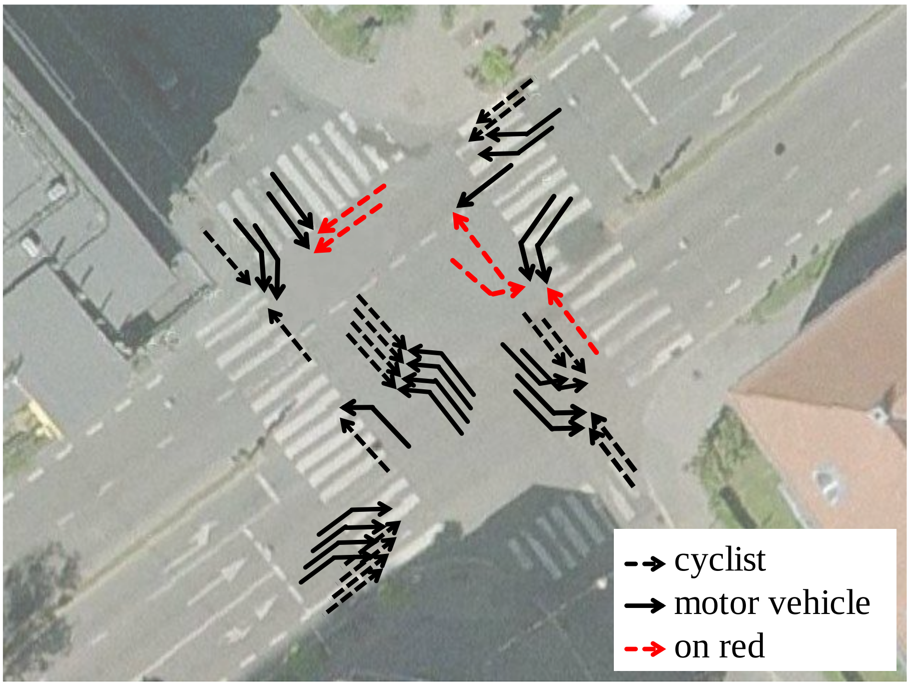


Figure 5. A sketch presenting the locations and types of the conflicts (example).

Conflict ID	Date	Conflict type	Road user 1	Road user 2	Time-to-Accident, sec.	Conflicting speed, km/h	Severity
28	2013-09-03, 07:09	Cyclist on red	cyclist	car	1,7	15	24
40	2013-09-03, 07:21	Cyclist on red	cyclist	moped	1,3	9	24
216	2013-09-04, 09:47	Cyclist on red	cyclist	car	1,1	32	26
254	2013-09-05, 07:28	Cyclist on red	cyclist	mc	1,9	14	24
22	2013-09-03, 07:01	Cyclist straight, Motor vehicle right	cyclist	car	1	12	25
32	2013-09-03, 07:12	Cyclist straight, Motor vehicle right	cyclist	car	1,1	10	25
207	2013-09-04, 09:11	Cyclist straight, Motor vehicle right	cyclist	car	1,2	8	25
292	2013-09-05, 08:57	Cyclist straight, Motor vehicle right	cyclist	car	1,6	12	24
396	2013-09-06, 09:50	Cyclist straight, Motor vehicle right	cyclist	car	0,8	11	25
934	2013-09-13, 07:40	Cyclist straight, Motor vehicle right	cyclist	car	1,4	17	25
62	2013-09-03, 07:59	Cyclist straight, Motor vehicle left	cyclist	car	1,5	10	24
496	2013-09-09, 09:28	Cyclist straight, Motor vehicle left	cyclist	car	0,9	12	25
594	2013-09-10, 08:33	Cyclist straight, Motor vehicle left	cyclist	car	1,4	13	24
710	2013-09-11, 08:10	Cyclist straight, Motor vehicle left	cyclist	car	1,7	19	24

Figure 6. Summary table of conflict observations (example).

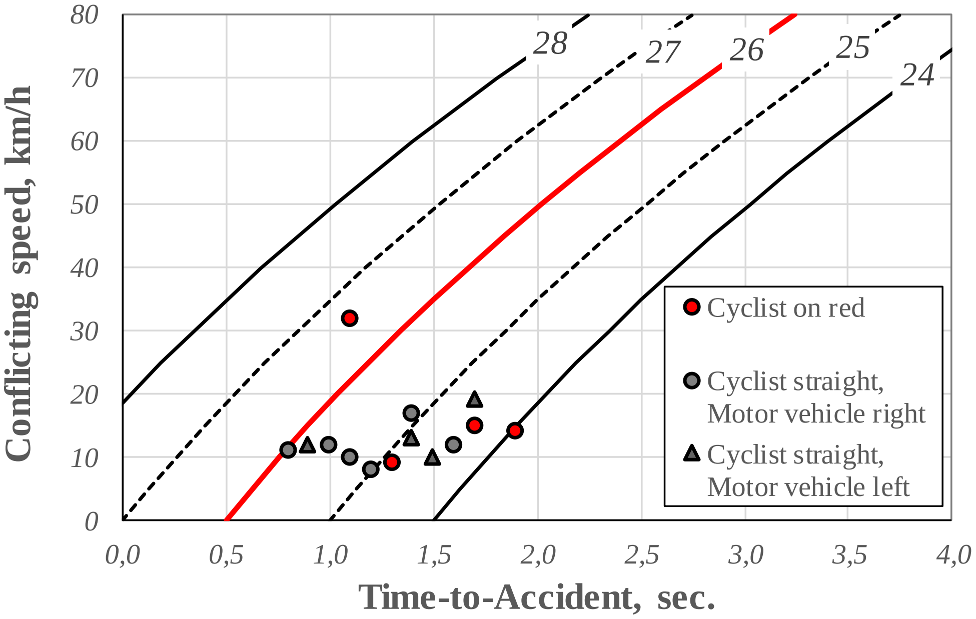


Figure 7. Conflict severity diagram (example).

Interpretation of the conflict study results includes:

- Identification of the common conflict types (e.g. by type of manoeuvre, types of road users involved, etc.);
- Identification of the locations where the conflicts take places;
- Identification of the particular circumstances for conflict occurrence (e.g. in the dark, peak or off-peak traffic, presence of parked/stopped vehicles obscuring the view, start or end of the green signal, etc.);
- Calculation of the mean Conflicting Speed and Time-to-Accident values.

In case of comparison between two sites or before/after studies, the following issues should be considered:

- Has accumulation of certain conflict types been eliminated?
- Has the severity of the conflicts decreased in general? For specific conflicts types?
- Have the mean Conflicting Speed and Time-to-Accident values changed?
- Have any new types of conflicts emerged not present before?

9 Complementary studies

For better understanding of the safety situation, the traffic conflict observations should be complemented with additional data collection, such as traffic counting, speed measurements, observation of road user behaviour, interviews with road users.

Accident data

It is always useful to compare the conflict study results with the accident data available. Do conflict and accidents reveal the same types of safety problems? Do they contradict each other? What could be the reasons (data quality, mismatch between time of the day and conditions of conflict observation and the accidents, etc.)? Very often, however, the accident data found for a single site is very limited in number, poor on details and thus hard to interpret.

Exposure

A number of traffic conflicts as such does not say much without a relation to the amount of the traffic activity taking place at the studied site, i.e. the exposure. The most theoretically correct measure of exposure is a number of encounters (simultaneous arrivals of two road users) counted separately for each type of interaction/conflict. If the number of encounters is known, it is possible to calculate the conflict rate (number of conflicts per number of encounters during the same period), i.e. the risk for an encounter to develop into a conflict.

It is, however, a hard work to count the simultaneous arrivals manually. Unless this data can be obtained with some automated tool, traffic flows can be used as a substitute. The conflict rate can then be expressed as, for example, a number of conflicts involving cyclist per number of passing cyclists during the observation time. An obvious drawback, of course, is that the amount of the conflicting traffic is not taken into account.

Traffic counting as a method is described in detail in the PIARC Road safety Manual (*PIARC, 2003*).

Speed measurements

Vehicle speed have a decisive role in both the risk of accident occurrence and the severity of the outcome. Therefore, safety analysis should always be complemented with vehicle speed measurements at the observed sites.

Speed measurement as a method is described in detail in the PIARC Road safety Manual (*PIARC, 2003*).

Behavioural observations

Having insight into the occurrence of different kinds of road user behaviour on the studied site gives a very good base to describe “what is going on“ on the site and what makes it “unsafe”. Aspects like red-walking, yielding behaviour, informal communication, etc. can provide insights into reasons of the safety problems. Hence, when possible, conflict observations should be complemented with behavioural observations of “normal” traffic performance.

Interviews with road users

Road users who often pass the studied site usually have some experience of unsafe situations they have observed or been involved into. To obtain the same knowledge, an observer coming from outside might need to spent long time observing the site. Hence, short interviews with passing-by road users may reveal important safety relevant issues, which in their turn could make a good basis for a consecutive behavioural/conflict observation.

10 Known issues and modifications of the Swedish TCT

The definitions and rules of the Swedish TCT described in Chapter 4 present the "classical" version of the Swedish TCT, finally shaped and validated in 1980s (*Hydén, 1987*). To understand why it looks as it does, it is necessary to understand the context of that time:

- Road safety was widely understood as "safety of motor vehicles", thus much focus on vehicle-to-vehicle conflicts.
- Human observers were the main "measuring tool" available, thus much "over-simplification" introduced to ease the task of the observers.
- Much higher speeds and less forgiving street designs in urban environment compared to modern conditions, thus high frequency of serious conflicts and the "luxury" of excluding low-severity events while still keeping the observation time reasonable short.

The context has changed since that time, though. As the road safety situation is improving, the serious conflicts become rare, too. The recent recommendation for a conflict study in a European city is to extend the observation period to at least one week, possibly longer.

Several issues have been discovered related to the use of the conflict severity diagram presented in Figure 2. The shape of the line separating the severity levels is defined by the ability of a motor vehicle to stop on a dry asphalt given a certain start speed. Such gradation based entirely on the ability to successfully brake before the collision is quite motivated for the motor vehicles as the most frequent (over 90%) evasive manoeuvre taken by drivers is indeed braking (*Hydén, 1987*). However, in case of cyclists, it is much more common to swerve rather than brake. As for pedestrians, they are able to stop or even jump back at literally no time.

Moreover, in conflicts including pedestrians or cyclists, they also very often become the relevant road users, i.e. take the first evasive action. As their speeds are generally lower compared to motor vehicles, the Conflict Speed value "pulls down" the conflict into lower severity.

At least two potential solution for this problem have been suggested. *Svensson (1998)* suggested that the line dividing the serious and not-serious conflicts should be moved one or two levels down (i.e. to the severity levels 25 or 24). This would include more conflicts into the final analysis and compensate for the under-scoring of the cyclist/pedestrian conflicts.

Shbeeb (2000) suggested that in the situations with pedestrian, it should always be the speed of the motor vehicle used as the Conflicting Speed, regardless to who is taking the evasive action. This provides more "fair" scores for the conflicts with VRUs, though still does not reflect the vulnerability of the pedestrian (conflicts involving two cars or a car and a pedestrian will be scored equally given the same speeds).

Thorough examination of the serious conflicts (scored so by observers) using accurate video processing software reveals that quite often there is no a strict collision course but a tiny time gap between which the road users would miss each other. Similarly, while examining the speed profiles, it is not always easy to point out the exact start of the evasive action (braking), even though observers are quite in agreement when identifying it in the video. All this indicate, that while the 'formal framework' of the Swedish TCT is quite strict, the observers have been 'stretching' it a bit when applying in practice and some subjective component plays an important role in conflict observation process. If the Swedish TCT is to evolve into more high-tech and automated version, the simple definitions as now might not be enough to 'reproduce' observers' judgements. Thus more research is still needed into what objective measures contribute to the subjective perceptions of the observers. With these modified definitions, new validation of the technique would also be necessary.

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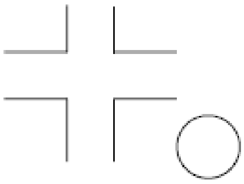
Appendix 1

The Swedish conflict recording form

Observer:________________________ Date:__________ Time:__________ Number:_____

City:____

Intersection:____



Weather: ☐ Sunny ☐ Cloudy ☐ Rainy

Surface: ☐ Dry ☐ Wet

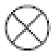
Time period ☐ ☐ ☐ ☐ ☐ ☐ ☐ ....

	Road-user I	Road-user II	Secondary involved III
Private car	☐	☐	☐
Bicycle	☐	☐	☐
Pedestrian	☐	☐	☐
Other	________	________	________
Sex (ped.)	☐ M ☐ F	☐ M ☐ F	☐ M ☐ F
Age (ped.)	________	________	________
Speed	_____ kmph	_____ kmph	_____ kmph
Distance to coll. point	_____ mtrs	_____ mtrs	
TA value	_____ sec	_____ sec	
Avoiding action			
Braking	☐	☐	
Swerving	☐	☐	
Acceleration	☐	☐	
Possibility to swerve	yes ☐ no ☐	yes ☐ no ☐	

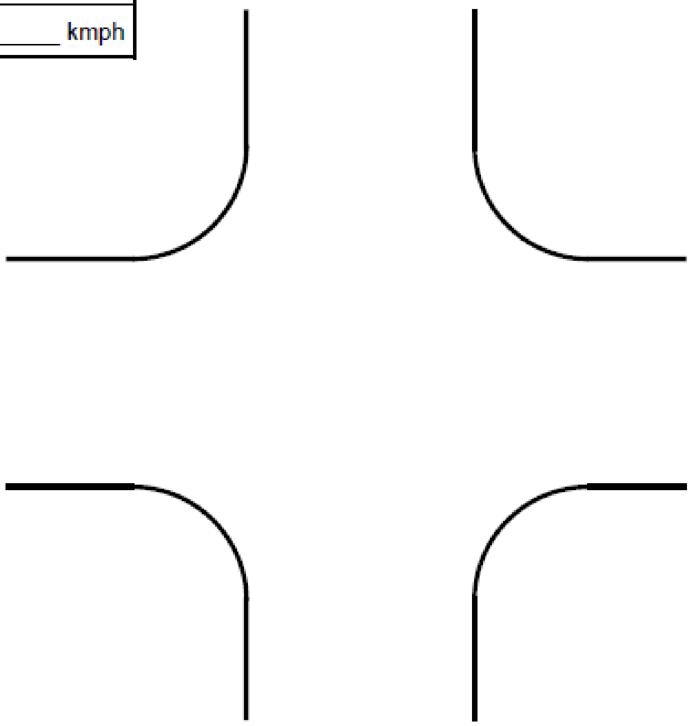
Description of the event:

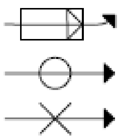
Continued on the other side: ☐ ⇒

Sketch including the positions of the road-users involved.

Mark your own position with 

If video is used mark the position of the camera with 





Private Car, Lorry, Bus.

Bicycle, Motorbike

Pedestrian

Appendix 2

TA-value based on conflict speed and distance

Speed		Distance, m																			
km/h	*m/s*	0,5	1	2	3	4	5	6	7	8	9	10	15	20	25	30	35	40	45	50	55
5	*1,4*	0,4	0,7	1,4	2,2	2,9	3,6	4,3	5,0	5,8	6,5	7,2									
10	*2,8*	0,2	0,4	0,7	1,1	1,4	1,8	2,2	2,5	2,9	3,2	3,6	5,4	7,2	9,0						
15	*4,2*	0,1	0,2	0,5	0,7	1,0	1,2	1,4	1,7	1,9	2,2	2,4	3,6	4,8	6,0	7,2	8,4	9,6			
20	*5,6*	0,1	0,2	0,4	0,5	0,7	0,9	1,1	1,3	1,4	1,6	1,8	2,7	3,6	4,5	5,4	6,3	7,2	8,1	9,0	9,9
25	*6,9*	0,1	0,1	0,3	0,4	0,6	0,7	0,9	1,0	1,2	1,3	1,4	2,2	2,9	3,6	4,3	5,0	5,8	6,5	7,2	7,9
30	*8,3*	0,1	0,1	0,2	0,4	0,5	0,6	0,7	0,8	1,0	1,1	1,2	1,8	2,4	3,0	3,6	4,2	4,8	5,4	6,0	6,6
35	*9,7*	0,1	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0	1,5	2,1	2,6	3,1	3,6	4,1	4,6	5,1	5,7
40	*11,1*	0,0	0,1	0,2	0,3	0,4	0,5	0,5	0,6	0,7	0,8	0,9	1,4	1,8	2,3	2,7	3,2	3,6	4,1	4,5	5,0
45	*12,5*		0,1	0,2	0,2	0,3	0,4	0,5	0,6	0,6	0,7	0,8	1,2	1,6	2,0	2,4	2,8	3,2	3,6	4,0	4,4
50	*13,9*		0,1	0,1	0,2	0,3	0,4	0,4	0,5	0,6	0,6	0,7	1,1	1,4	1,8	2,2	2,5	2,9	3,2	3,6	4,0
55	*15,3*		0,1	0,1	0,2	0,3	0,3	0,4	0,5	0,5	0,6	0,7	1,0	1,3	1,6	2,0	2,3	2,6	2,9	3,3	3,6
60	*16,7*		0,1	0,1	0,2	0,2	0,3	0,4	0,4	0,5	0,5	0,6	0,9	1,2	1,5	1,8	2,1	2,4	2,7	3,0	3,3
65	*18,1*		0,1	0,1	0,2	0,2	0,3	0,3	0,4	0,4	0,5	0,6	0,8	1,1	1,4	1,7	1,9	2,2	2,5	2,8	3,0
70	*19,4*		0,1	0,1	0,2	0,2	0,3	0,3	0,4	0,4	0,5	0,5	0,8	1,0	1,3	1,5	1,8	2,1	2,3	2,6	2,8
75	*20,8*		0,0	0,1	0,1	0,2	0,2	0,3	0,3	0,4	0,4	0,5	0,7	1,0	1,2	1,4	1,7	1,9	2,2	2,4	2,6
80	*22,2*		0,0	0,1	0,1	0,2	0,2	0,3	0,3	0,4	0,4	0,5	0,7	0,9	1,1	1,4	1,6	1,8	2,0	2,3	2,5
85	*23,6*		0,0	0,1	0,1	0,2	0,2	0,3	0,3	0,3	0,4	0,4	0,6	0,8	1,1	1,3	1,5	1,7	1,9	2,1	2,3
90	*25,0*		0,0	0,1	0,1	0,2	0,2	0,2	0,3	0,3	0,4	0,4	0,6	0,8	1,0	1,2	1,4	1,6	1,8	2,0	2,2
95	*26,4*		0,0	0,1	0,1	0,2	0,2	0,2	0,3	0,3	0,3	0,4	0,6	0,8	0,9	1,1	1,3	1,5	1,7	1,9	2,1
100	*27,8*		0,0	0,1	0,1	0,1	0,2	0,2	0,3	0,3	0,3	0,4	0,5	0,7	0,9	1,1	1,3	1,4	1,6	1,8	2,0

Conflict diagram