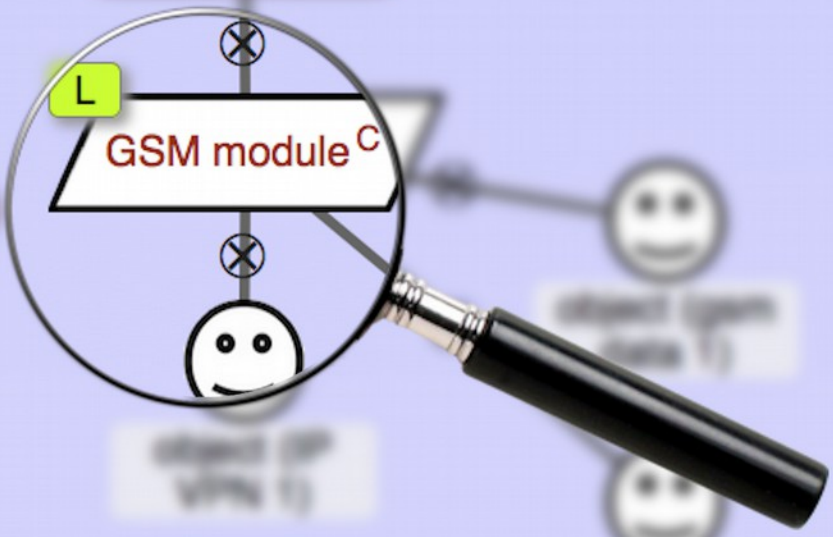
The Raster Method

application manual



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Source: https://github.com/EelcoV/RasterTool

The Raster tool can be found at the above URL.

This work is sponsored by Radiocommunications Agency Netherlands, and by University of Twente.

http://www.agentschaptelecom.nl/

http://www.utwente.nl/

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1 Introduction

Introduction and guide to this document.

1.1 The problem

Organisations use many types of telecommunication services: fixed and mobile telephony, videoconferencing, internet, encrypted links between offices, etc. In the last decade, organisations have become much more dependent on these services. Whereas in the past a telephone outage was an inconvenience, today the failure of telecom services often makes it impossible to do business at all. And as organisations move online and into the cloud, reliability of telecom services becomes even more essential.

At the same time, technological and market changes have made it more difficult to assess the reliability of telecommunication services. Networks grow continuously, new technologies replace old ones, and telecom operators outsource and merge their operations. For any end-to-end telecom service, several telecoms operators will be involved, and none of them can understand how important that service is to each customer.

This increased dependency applies even more to organisations that fulfil a vital role in society, such as fire services, medical care, water boards, utilities, banks, etc.

It is therefore important that organisations in general, and organisations that supply critical infrastructures in particular, understand the vulnerabilities and dependencies of the telecom services they use. This document describes a method, called Raster, to assist in this understanding.

The goal of Raster is that the organisation becomes less vulnerable to telecom failures. To reduce the vulnerability, the organisation must first understand what can go wrong with each telecom service they use. Also, these risks must be ranked, so that the most pressing risks can be addressed first. Raster helps a team of analysts to map and investigate one or more telecom services for an organisation. The result is a report, showing which risks should be addressed first, and why. Selection and execution of countermeasures is the next logical step, but is not part of the Raster method.

1.2 The Raster method

Incidents with availability of telecom services often happen because of component failures: an underground cable is damaged by a contractor, a power failure causes equipment to shut down. To prepare for these incidents, the organisation must first realise that the cable and equipment exist. An important part of the Raster method is therefore to draw a diagram showing all components involved in delivering the service.

Incidents can also happen when a single event leads to the simultaneous failure of two or more components. For example, two cables in the same duct can be cut in the same incident, or a software update can cause several servers to misbehave.

These failures are called *common cause failures*, and they are dangerous because their impact can be quite large.

Major steps in the Raster method are to draw service diagrams, and to assess the likelihood and potential impact of single and common cause failures. However, unlike other methods Raster does not take a narrow numerical approach to assessing risks.

Risks with low probability and high effects are especially important. These rare but catastrophic events have been called “black swans”. Raster helps to uncover black swans in telecom services.

Risk assessments are always in part subjective, and information is hardly ever as complete as analysts would like it to be. This does not mean that biases and prejudices are acceptable. Raster tries to nudge analysts into a critical mode of thinking. Uncertainty is normal, and assessments can be explicitly marked as “Unknown” or “Ambiguous” if a more specific assessment cannot be made. Raster can be applied even when much of the desired information on the composition of telecom networks is unavailable or unknown. Missing information can be gradually added.

To avoid a narrow risk assessment, the Raster method is applied by a team of experts, each having his own area of expertise. Raster facilitates cooperation between experts of different backgrounds.

Raster facilitates the construction of a recommendation using a tested methodical analysis. This recommendation is not just based on the technical aspects of failure of telecoms services, but also takes account of the societal impact of failures, and of risk perceptions of external stakeholders.

The following parties are involved in applying the Raster method.

- The case organisation: the method is executed on request of an organisation. This organisation is the requesting client of the study.
- The analysts: the method is executed by a group of professionals. It is essential that this group consists of multiple people. Not only does a single person seldom possess all required knowledge, it is also important that the study leads to an objective and impartial assessment, as much as possible free from personal preferences or personal blind spots.

  The team needs to encompass knowledge on essential business activities and technical aspects of telecommunication networks and services. Additionally, it will be useful if team members have some experience with risk assessment, and with the Raster method in particular. Because of this range of knowledge it will be necessary to include employees of the case organisation in the team of analysts.
- The sponsor: the person or entity representing the case organisation for the purpose of the study. Typically this will be a manager from the case organisation.
- The decision makers: the output of the method is a set of recommendations and supporting argumentation that serve as the basis for the selection of risk treatment decisions. Responsibility for the selection does not belong to the analysts, but to the decision makers. The decision maker can be sponsor, but these roles can also be separate.
- The external stakeholders: this category includes all parties that are not part of the case organisation and not involved in the use of telecom services, but do have

interests that may be harmed by the risks or chosen risk treatments. External stakeholders may be 'the public' in general, or a specific group such as those people living in the neighbourhood of a facility, the patients of a hospital, customers, etc.

1.3 About this manual

This manual is for the professionals who will execute the Raster method. It explains the method and provides guidance. These professionals can either be telecom experts or experts in any other field whose expertise is needed.

In this manual, the words 'must', 'should', and 'may' have a well-defined meaning.

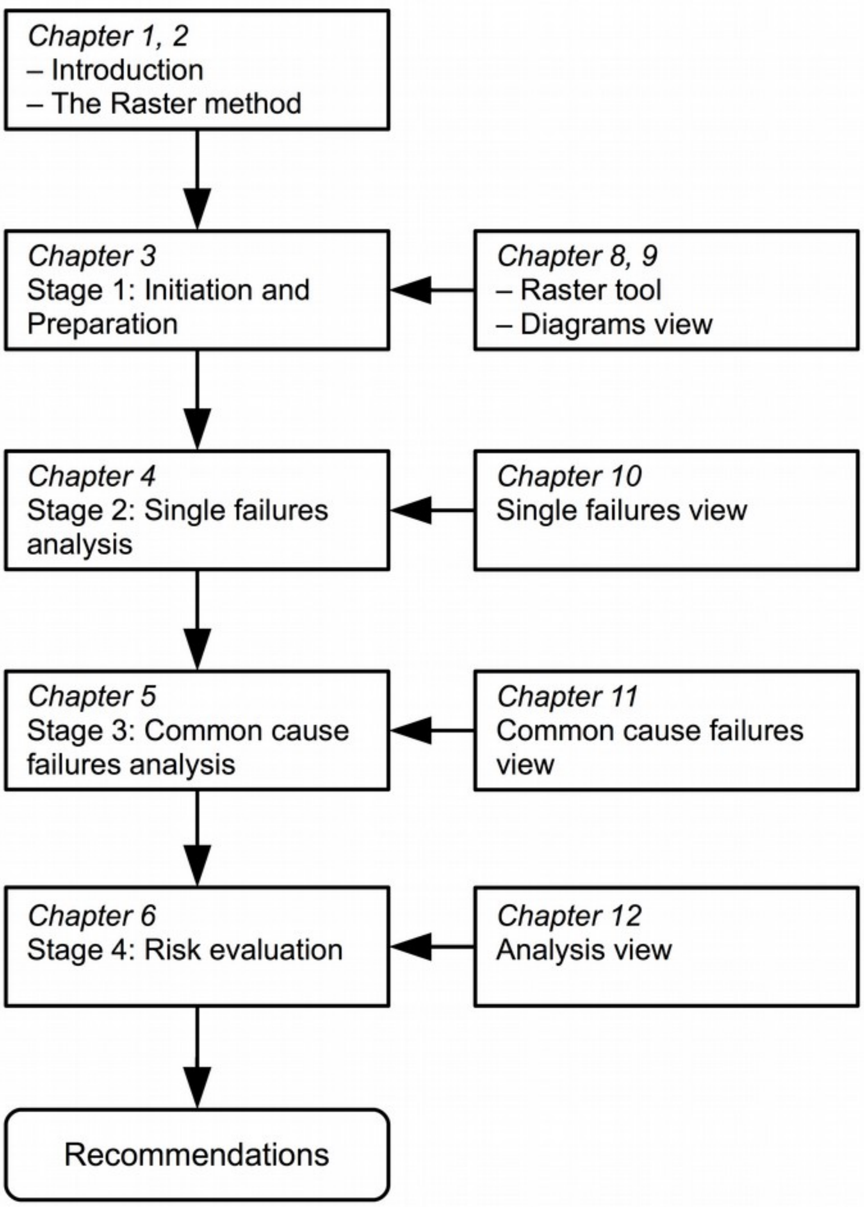
- *Must* indicates a compulsory aspect of the Raster method; under no circumstances can the activity be omitted.
- *Should* indicates a recommended activity, that should only be omitted if the implications are fully understood. This must be a conscious decision.
- *May* indicates a suggested but optional activity, that can be included or omitted at will.

Examples, notes and tips are typeset in text boxes.

> This would be an example, note, tip or shortcut.

1.4 Outline of this manual

Chapters 3 to 6 describe the Raster method; chapters 8 to 13 describe the Raster tool that aids the creation of diagrams and the analysis of Single Failures and Common Cause Failures. When executing an analysis using Raster, you will proceed as in the figure overleaf.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2 The Raster method

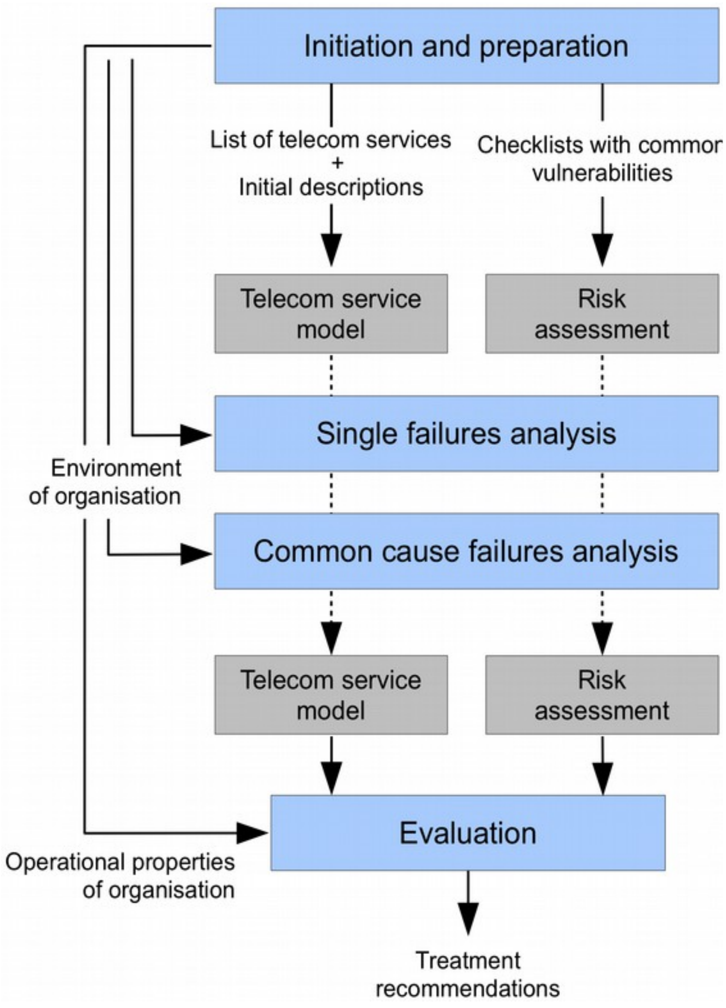
General outline of the Raster method and telecom service diagrams.

2.1 Outline

When using the Raster method, you and the rest of your team will perform a number of tasks. The method will guide you through these tasks in a methodical way, and the Raster tool will assist you in recording your progress. Based on your collective knowledge and expert judgement you will make estimates about the likelihood and impact of various vulnerabilities affecting the telecom services. Based on this analysis, you and your team will draft suitable risk treatment recommendations. The result of your efforts is a report that can be used by a decision maker to take informed business decisions about accepting, reducing, or avoiding the risks.

Raster consists of four stages, shown in the figure below.

1. Initiation and preparation
2. Single failures analysis
3. Common cause failures analysis
4. Evaluation



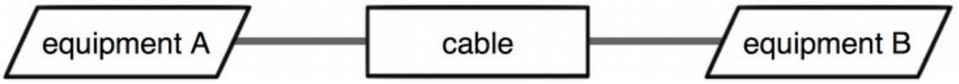
1. The Initiation and Preparation stage describes the scope and purpose of the assessment. Which telecom services are involved, which users can be identified, who are external stakeholders, and what are the characteristics of the environment in which these services are used?
2. The Single Failures Analysis stage creates a telecom service diagram for each telecom service in use. These diagrams describe the most relevant telecommunication components, including cables wireless links, and equipment items. These components are potentially vulnerable. The diagram does not have to be complete in all details. Parts of networks that are less relevant can be captured using a single “cloud” (unknown link). For all components an assessment of all applicable vulnerabilities is done. Only independent, single failures are taken into account during this stage.
3. The Common Cause Failures Analysis stage takes closer look at failure causes that lead to the failure of multiple components at once. One example is that of independent telecom services that both have a cable in the same underground duct. A single trenching incident may cut both cables at the same time, causing both services to fail. Another example is a large-scale power outage, causing equipment over a large area to fail simultaneously.
4. The Risk Evaluation stage contains the risk evaluation and creation of the final report. The overall risk level is assessed, and recommendations are done for risk treatment. These recommendations take into account the possible reactions of external stakeholders. The recommendations and their supporting argumentation form the final output of the Raster method.

Chapters 3 to 6 describe each stage in detail.

> To facilitate the creating of diagrams and analysis of single and common cause failures, the Raster tool is available. This tool is described in the second part of this document, starting from Chapter 8. In principle, stages 2 and 3 can be used without the tool. However, the tool comes highly recommended and this manual assumes that the method will be used together with the tool.

2.2 Telecommunication service diagrams

Diagrams are central to the Raster method. A telecom service diagram describes the physical connectivity between components of a telecom service. Diagrams consist of nodes that are connected by lines. Each line represents a direct physical relation. It indicates that the nodes are attached to each other. There cannot be more than one line between two nodes; nodes are either connected or they are not.



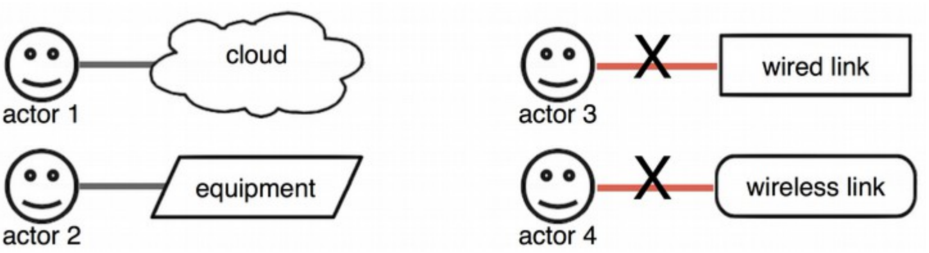
Lines are not the same as cables. When two equipment items are connected via a cable, three nodes are used as in the picture above. The line between equipment and cable shows a physical connection: the cable is plugged into the equipment.

There are five types of nodes, each identified by its unique shape.

2.2.1 Actors

Actors represent the (direct) users of telecom services. An actor can represent a single individual, or a group of individuals having the same role, e.g. 'journalists'

or 'citizens'. Maintenance personnel are not modelled as actors, as they do not participate in communication.

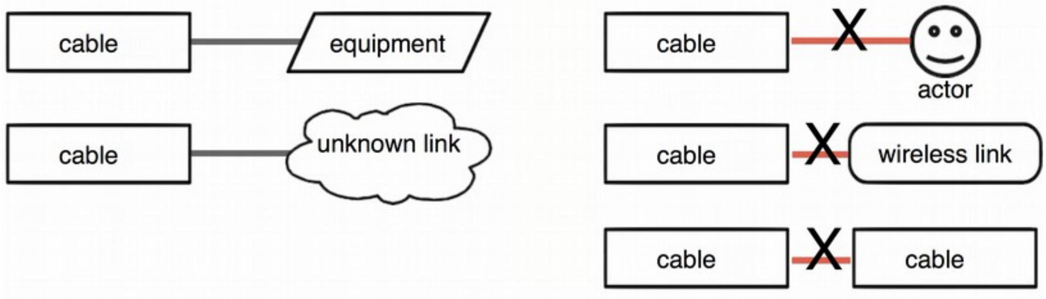


An actor can only be connected to components of type 'equipment' or 'unknown link'. Actors cannot be connected directly to wired or wireless links, and the Raster tool will not allow such connections.

There must be at least two actors in the diagram. There must at least be a person communicating, and one other person to communicate with.

2.2.2 Wired links

Wired links represent passive, physical cables, including their connectors, fittings and joints but excluding any active components such as amplifiers or switches. Fiber optic cables, coaxial cables, and traditional telephony copper pairs are typical examples of wired links. The two equipment items connected by the link are not part of the wired link itself, and need to be included in the model separately, either as equipment items or unknown links.



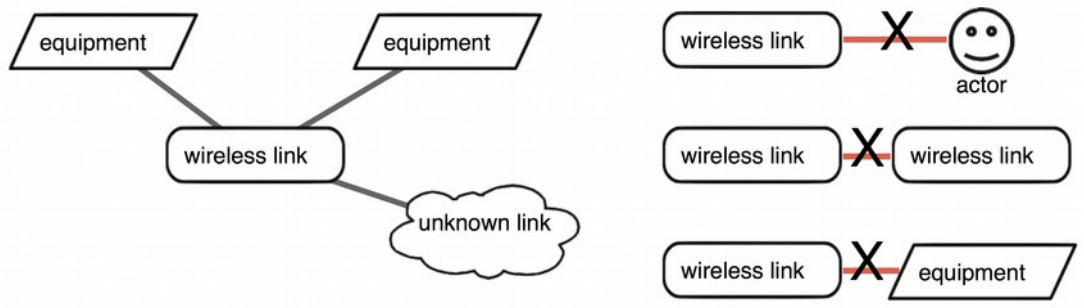
Each wired link has exactly two connections, each to a component of type either 'equipment' or 'unknown link'. To connect a wired link to an actor, wireless link, or an other wired link, place an equipment node in between.

Each wired link has some fixed capacity, a physical location (including a height above or below ground level). These properties need to be known in sufficient detail.

2.2.3 Wireless links

Wireless links represent direct radio connections, excluding any intermediate components. The transmission and reception installations are not part of the wireless link, and have to be modelled separately as equipment items. A wireless link can connect two or more nodes.

Each wireless link has a fixed capacity, but unlike wired links a wireless link does not always have a fixed location. Transmitters and receivers can be mobile or nomadic. The coverage area depends on factors such as transmission power and antenna properties. Wireless links have a fixed frequency or band. All of these properties need to be described in sufficient detail.



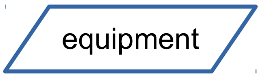
Each wireless link has at least two connections, each to a component of type either 'equipment' or 'unknown link'. It can have more than one, as in the example above. To connect a wireless link to an actor, equipment, or an other wireless link, place an equipment node in between.

2.2.4 Unknown links

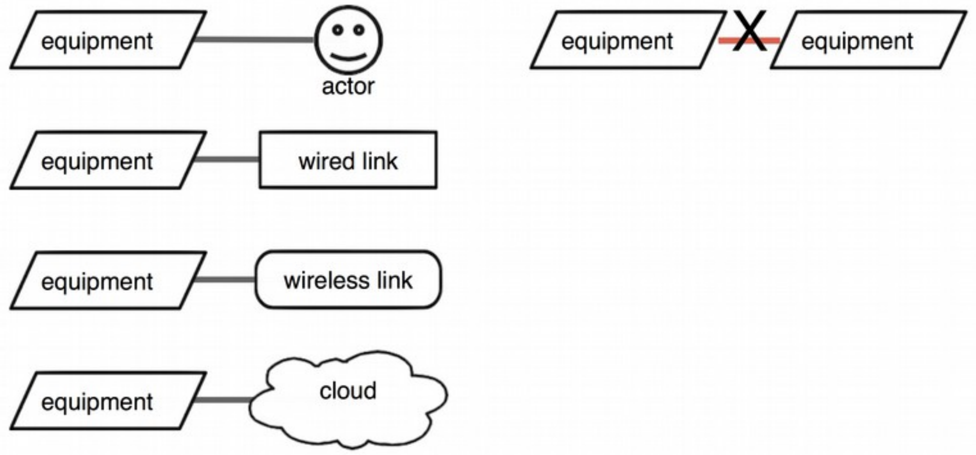
Unknown links (cloud shapes) represent parts of networks for which insufficient information is available, or that do not need to be described in detail. Unlike wired and wireless links, that represent a single communication channel, unknown links are composed of equipment and wired and wireless links.

Because unknown links are collections of equipment and wired and wireless links, they can be used in any place where these nodes can be used. In short, unknown links can connect to any other node type. Also, unknown links can be connected to any number of nodes.

2.2.5 Equipment



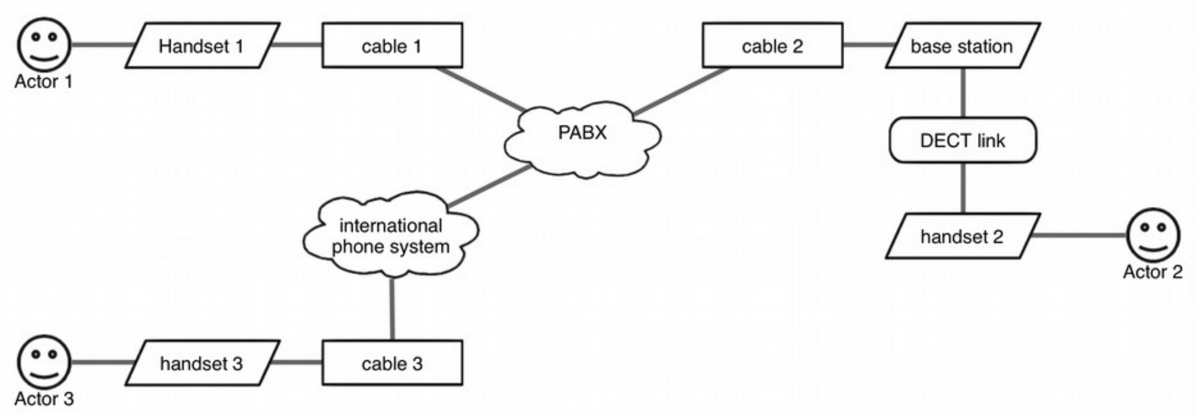
Equipment nodes represent all other physical components of telecom networks, such as switches, exchanges, routers, amplifiers, radio transmitters, radio receivers etc. An equipment node may model a single piece of equipment or an entire installation.



Each equipment node must be connected with at least one other component. An equipment node cannot be connected directly to another node of type 'equipment'.

2.2.6 Example

The figure below shows an example of a valid telecom service diagram. The diagram shows three actors, communicating via telephony. Two actors are connected to the same private exchange (PABX); the third actor is abroad. One actor uses a wireless DECT handset and base station, the others use fixed handsets. We have no knowledge (yet) of the other portions of the network, other than that some PABX must exist, and some kind of international telephony network to facilitate the calls.



3 Stage 1 — Initiation and preparation

Define shared purpose and bounds to the study.

Before the study is started its scope must be made clear to the analysts and to the sponsor. The responsibilities and tasks of the case organisation must be described in some detail. Also, the position of the organisation within the wider system of suppliers, customers and stakeholders must be laid out.

In stage 1 you will collect the information that you need to complete the other stages. The result is a report and agreement from the sponsor to proceed.

The Initiation and Preparation stage consists of the following steps:

1. Identify telecom services
2. Identify actors
3. Describe disaster scenarios
4. Create Stage 1 report
5. Obtain approval from sponsor

3.1 Identify telecom services

Create a list of all telecommunication services that are used by the case organisation. This list must be exhaustive. If a service is accidentally omitted, no risk assessment will be performed on it, and dependencies between the service and other services will not be discovered. As a result, decision makers may take unnecessary or ineffective countermeasures, or overlook necessary countermeasures.

To create the list of telecom services, the following information sources may be useful:

- The initiating problem statement, project initiation document, or request for proposals.
- Interviews with executives and operational staff from the case organisation.
- Observation of operational staff in exercises or real-life operations.
- Disaster preparedness plans.
- Reports or evaluations of past exercises.
- Internal formal procedures, operational guides, process manuals.
- Reference materials used during crisis response.

Briefly describe each telecom service. At this stage it is not yet necessary to describe the technical implementation, but if information is available on such items as handsets, terminals, or links, then this should be included in the descriptions.

If a telecom service acts as backup to some other telecom service, or when the service itself has fallback options, then these must be described as well.

The descriptions must also include the relevance of the telecom service to the operations of the organisation. That is, is the service essential, or merely a 'nice to have'?

It will also be useful at this stage to start a glossary of abbreviations and definitions of special terms that may not be clear to all analysts, or to the sponsor.

3.2 Identify actors and external stakeholders

List, for each telecom service, the actors who may make use of that service. Main actors are members of the case organisation. All other actors are secondary actors. Actors can be the initiating party of communication session (calling party) or the receiving party (called party), or both.

List all external stakeholders to the case organisation.

Actors and external stakeholders may be identified using the same information sources as listed above for telecom services.

3.3 Describe disaster scenarios

Before the analysis can start, it must be clear to which threats this organisation may be exposed. For example, the in-company fire service in charge of chemical plant safety will be confronted with different potential disasters than a crisis team controlling the spread of agricultural diseases. The latter is unlikely to be affected by violent destruction of hardware. Consequently, the threats to their telecom services will be very different in nature.

The threats to telecom services and their mechanisms must be described in as much detail as possible. Disaster scenarios describe the threats, their effects and mechanisms, their likelihood, and the required response from the case organisation.

> In the Netherlands tornados seldom lead to damage to infrastructures. Typically, the threat of tornados will therefore be excluded from disaster scenarios. Flooding from sea or riverbeds, however, are quite common, and will likely be included.
>
> For some studies intentional human-made events (crime, terrorism) are highly relevant. For other studies it may suffice to focus on accidental events only. The scope of the study need not be limited to technical aspects.

When describing a disaster, the effects that it will have on telecom components is the most important part. To better understand the reactions of the general public it may be useful to also include some graphic descriptions of events that could be experienced by citizens, or that could be published in the media. This may facilitate the assessment of social risk factors in the Risk Evaluation stage.

It may be possible to reuse disaster scenarios from previous risk assessments, thus shortening the amount of work needed.

3.4 Create stage 1 report

The results from Stage 1 must be recorded because the analyst will need to refer to this information during subsequent stages.

The following is a common outline of the output document of the Initiation and Preparation stage. This report forms the introduction to the final report (see section 6.4).

1. Executive summary to the Stage 1 report.
2. About the case organisation (internal scope):

   a. Position within wider system of stakeholders.
   b. Sponsor, decision makers, and analysts.
   c. Roles, tasks, and responsibilities of the case organisation.
   d. Telecom services used, with a description of the implementation, role and purpose, and fallback and backup options.
   e. Actors, including main actors, and their roles, tasks, and responsibilities.
3. About the environment of the case organisation (external scope):
   a. Disaster scenarios, with descriptions.
   b. External parties with whom the main actors may communicate, and other external stakeholders.
4. Glossary.

3.5 Obtain approval from sponsor

All analysts must participate in a review of the Stage 1 report. All analysts must agree on its contents by consensus.

The Stage 1 report must then be presented to and discussed with the sponsor. The list of telecom services may contain unexpected services. The unexpected appearance of a service is informative, since it indicates that the risk assessment and preparation of the case organisation are insufficient, and that disaster response plans are incomplete.

The results of the Initiation and Preparation stage determine to a large extent the course of the risk assessment in the later stages. It is therefore important that the sponsor also agrees to the outcome of this stage, and gives formal agreement to the resulting documentation. As a consequence, the documents must be understandable to non-experts. A glossary may be helpful to that effect. Also, an executive summary should be written.

4 Stage 2 — Single failures analysis

Describe telecom service networks and analyse vulnerabilities of components.

In this stage you will create a telecom service diagram for each telecom service, and assess the vulnerabilities on each of its components. This will give you a good understanding of the inner workings of each telecom service, and a first impression of its risks.

The result will be recorded in the Raster tool: telecom service diagrams and assessment of Frequency and Impact on vulnerabilities of diagram components.

The Single Failures Analysis stage consists of the following steps:

1. Update the checklists of vulnerabilities
2. Draw initial diagrams
3. Analyse the vulnerabilities of components (assess frequency and impact)
4. Expand unknown links
5. Review

4.1 Update the checklists of vulnerabilities

Based on the disaster scenarios that were described in Stage 1, you must describe the most common vulnerabilities of network components. Checklists are used for this. A checklist contains the name and description of the most common vulnerabilities. Good checklists make the analysis process faster and easier.

Create a fresh Raster project (see section 8.2.1), and inspect the predefined checklist for each type (see section 9.2). Add new vulnerabilities as deemed necessary. Include vulnerabilities that apply to most components of that type; omit vulnerabilities that only apply to a few components. The checklists do not have to be complete; any particular network component may have specific vulnerabilities that do not occur in the checklist. However, when the most common vulnerabilities are included in checklists, few special cases need to be considered.

There are three checklists, one each for equipment, wired and wireless links. For actor components no checklist exists. Vulnerabilities of actors are outside the scope of the Raster method. Also, unknown links do not have a separate checklist. They may contain any of the other component types, and therefore all vulnerabilities of the three checklists may apply to unknown links.

> Vulnerabilities of actors are not taken into account. For example, Raster does not handle an actor misinterpreting a received message. However, configuration errors, incorrect handling of handsets or cyber crimes can be taken into account. These vulnerabilities are modelled in Raster as part of equipment components, not as part of the actor responsible for them. Maintenance personnel are not included in the diagrams as actors.

4.2 Draw initial diagrams

In the Raster tool, create a diagram tab for each telecom service (see Section 9.3.1).

Then, for each telecom service, draw an initial diagram based on the information that is currently available. The diagrams will likely not be very detailed yet. At the very least all actors involved with the service must be drawn. Note that it is always possible to create a diagram; if absolutely no information is available beyond the actors involved then the actors can simply be connected using an unknown link ("cloud" symbol). Drawing and editing diagrams using the Raster tool is explained in Section 9.3.

When creating diagrams, the following guidelines may be helpful:

- A cable containing multiple fibers or strands should be modelled as a single wired link. Two cables in the same duct should be modelled by two wired links in the diagram.
- Point-to-multipoint connections should be modelled using a single wireless link, but may sometimes be more conveniently modelled using separate wireless links to each receiving node. If you know in advance that the link to each individual node is subject to identical risks, then for simplicity a single wireless link should be used.
- Equipment components can be a single device, or an entire installation. For example, a small telephone exchange may be modelled as a single equipment node. However, installations such as these contain multiple cables and sub-components. Often it is not necessary to model these cables and equipment items separately. When an installation is separated over multiple rooms or when wireless links are used then the sub-components should be modelled separately. Alternatively, an unknown link may be used instead of an equipment item.

4.3 Analyse the vulnerabilities of components

This activity must be performed for each component in turn. Each step, a component is selected for analysis.

4.3.1 Add and remove vulnerabilities

Inspect the listed vulnerabilities of the component. The initial list is a copy of the generic checklist for that type. Other vulnerabilities may exist that were not in the checklist. These vulnerabilities must be added. The disaster scenarios that were prepared in Stage 1 must be used as guidance in decisions to add vulnerabilities.

> Example: Telecommunication satellites are vulnerable to space debris. This vulnerability does not apply to any other kind of equipment, and will therefore not be in the equipment checklist. On the other hand, satellites are not vulnerable to flooding. Therefore "Collision with space debris" must be added, and "Flooding" must be removed from the list of satellite vulnerabilities.

A vulnerability must not be removed unless it is clearly nonsensical, e.g. configuration errors on devices that do not allow for any kind of configuration, or flood damage to a space satellite. To be removed, a vulnerability must be physically impossible, not just very unlikely in practice. In all other cases the frequency and impact of the vulnerability should be assessed (although they can both be set to

Extremely low), and the vulnerability must be part of the review at the end of Stage 2.

It is important that vulnerabilities that are merely unlikely but not physically impossible are retained in the analysis, because such vulnerabilities could have an extremely high impact. Low-probability/high-impact events must not be excluded from the risk analysis.

4.3.2 Assess vulnerabilities

When the list of vulnerabilities for the component is complete, each vulnerability must be assessed. The analysts, based on their collective knowledge, estimate two factors:

1. the likelihood that the vulnerability will lead to an incident (its frequency), and
2. the impact of that incident.

Both factors Frequency and Impact are split into eight classes, summarised in Tables 4.1 and 4.2. The classes do not correspond to ranges (a highest and lowest permissible value); instead they mention a typical, characteristic value for the class. The selection of the proper class may require a discussion between analysts. Analysts must provide convincing arguments for their choice of class.

Sometimes a factor (a likelihood or impact) is extremely large, or extremely small. Extremely large values are not simply very big, but too big to fit in the normal scale, unacceptably high and intolerably high. Likewise, extremely small values are outside the scale of normal values, and sometimes may safely be ignored. Extreme values fall outside the normal experience of analysts or other stakeholders, and normal paths of reasoning cannot be applied.

If no consensus can be reached between the analysts, the class *Ambiguous* must be assigned. In the remarks the analysts should briefly explain the cause for disagreement, and the classes that different analysts would prefer to see.

A limited amount of uncertainty is unavoidable, and is normal for risk assessments. However, when uncertainty becomes too large, so that multiple classes could be assigned to a factor the class *Unknown* must be assigned.

The Raster tool assists in recording the analysis results. The tool will also automatically compute the combined vulnerability score for each vulnerability, and the overall vulnerability level for each node (see sections 9.3.11 and 10, and section 13.2 for technical details).

> Do not blindly trust your initial estimate of frequency and impact. You must not rely only on information that confirms your estimate, but also actively search for contradicting evidence.

4.3.3 Assess frequency

The factor Frequency indicates the likelihood that the vulnerability will lead to an incident with an effect on the telecom service. All eight classes can be used for Frequency (see Table 4.1).

A frequency of “once in 50 years” is an average, and does not mean that each 50 years an incident is guaranteed to occur. It may be interpreted as:

- The average timespan between incidents on a single component is 50 years.

- For a set of 50 identical components, each year on average one of them will experience an incident.
- Each year, the component has a 1 in 50 chance of experiencing an incident.

When the life time of a component is 5 years (or when the component is replaced every 5 years) the frequency of a vulnerability can still be "once in 500 years".

> Example: a component is always replaced after one year, even if it is still functioning. On average, 10% of components fail before their full year is up. The general frequency for this failure is therefore estimated as "once in 10 years" even though no component will be in use that long.
>
> Note that this value is between the characteristic values for High and Medium. The analysts must together decide which of these two classes is assigned.

Class	*Value*	*Symbol*
High	Once in 5 years. For 100 identical components, each month 1 or 2 will experience an incident.	H
Medium	Once in 50 years. For 100 identical components, each year 2 will experience an incident.	M
Low	Once in 500 years. For 100 identical components, one incident will occur every five years.	L
Extremely high	Routine event. Very often.	V
Extremely low	Very rare, but not physically impossible.	U
Ambiguous	Indicates lack of consensus between analysts.	A
Unknown	Indicates lack of knowledge or data.	X
Not yet analysed	Default. Indicates that no assessment has been done yet.	–

Table 4.1: Characteristic values for frequency classes.

Use the following three-step procedure to determine the factor Frequency:

1. Find the frequency class that applies to this type of node in general.

   This can be based on, for example, past experience or expert opinion. If available, MTBF (mean time between failures) figures or failure rates should be used.

2. Think of reasons why this particular node should have a lower or higher frequency than usual.

   Existing countermeasures may make the frequency lower than usual. For example, if an organisation already has a stand-by generator that kicks in when power fails, then the frequency of power failure incidents is thereby reduced. Remember that the frequency does not reflect the likelihood that the vulnerability is triggered, but the likelihood that the vulnerability will lead to an incident.

   For some components monitoring can detect failures that are imminent before they occur. This also will reduce the frequency of incidents. Another example is the use of premium quality components, or secure and controlled equipment rooms. All of these measures make incidents less likely.

The disaster scenarios may be an indication that the frequency should be higher than usual. In crisis situations it is often more likely that an incident will occur. For example, power outages are not very common, but are far more likely during flooding disasters. These disasters themselves are very uncommon. The overall frequency is therefore determined by:

- the likelihood of power outages during normal circumstances, and
- the likelihood of power outages during a flood, combined with the likelihood of flooding.

3. Decide on the frequency class for this particular node.

   Typically either Low, Medium, or High will be used. If neither of these accurately reflect the frequency, one of the extreme classes should be used. If no class can be assigned by consensus, one of Ambiguous or Unknown should be used.

4.3.4 Assess impact

The factor Impact indicates the severity of the effect when a vulnerability does lead to an incident. This severity is the effect to the service as a whole, not its effect to the component that experienced the vulnerability. For example, a power failure will cause equipment to stop functioning temporarily. This is normal, and in itself of little relevance, unless it has an effect on the availability of the telecom service. The power failure could cause the service to fail (if the equipment is essential), but could also have a no effect at all (if the equipment has a backup). Or any effect in between.

Only the effects on the telecom service must be taken into account in this stage. Loss of business, penalties, and other damage are not considered, but may be relevant during risk evaluation (see Section 6.3.2).

The damage may be caused by an incident that also affects other components of the same telecom service. For example, a cable may be damaged by an earthquake; the same earthquake will likely cause damage to other components as well. However, this additional damage must not be taken into account. Only the damage resulting from the damage to this component must be considered. The next stage, common cause failures analysis, takes care of multiple failures due to a single incident.

> The impact of some vulnerability on a component covers:
>
> – only effects to the service, not the effects to the component itself,
>
> – only effects to the service, not subsequent damage to the organisation,
>
> – only effects due to damage this single component, not effects due to the failure scenario.

All eight classes can be used for Impact. Characteristic values for the classes high, medium, and low are given in Table 4.2.

Use the following three-step procedure to determine the factor Impact:

1. Choose the impact class that most accurately seems to describe the impact of the incident.
2. Think of reasons why the impact would be higher or lower than this initial assessment.

Existing redundancy can reduce or even annul the impact. For example, a telecom service may have been designed such that when a wireless link fails, a backup wired link is used automatically. The impact of the wireless link failing is thereby reduced.

Monitoring and automatic alarms may reduce the impact of incidents. When incidents are detected quickly, repairs can be initiated faster. Keeping stock of spare parts, well trained repair teams, and conducting regular drills and exercises all help in reducing the impact of failures and must be considered in the assessment. On the other hand, absence of these measures may increase the impact of the incident.

3. Decide on the impact class.

   Typically either Low, Medium, or High will be used. If neither of these accurately reflect the impact, one of the extreme classes should be used. If no class can be assigned by consensus, one of Ambiguous or Unknown should be used.

Class	*Value*	*Symbol*
High	Partial unavailability, if unrepairable. Total unavailability, if long-term.	H
Medium	Partial unavailability, if repairable (short-term or long-term). Total unavailability, if short-term.	M
Low	Noticeable degradation, repairable (short-term or long-term) or unrepairable.	L
Extremely high	Very long-term or unrepairable unavailability of the service.	V
Extremely low	Unnoticeable effects, or no actors affected.	U
Ambiguous	Indicates lack of consensus between analysts.	A
Unknown	Indicates lack of knowledge or data.	X
Not yet analysed	Default. Indicates that no assessment has been done yet.	–

Table 4.2: Characteristic values for impact classes.

It typically does not matter for the selection of impact class whether some or all actors are affected. All actors are important; they would not appear in the diagram otherwise. However, if the analysts agree that only very few actors are affected they can select the next lower class (e.g. Low instead of Medium).

The meaning of “short-term” and “long-term” depends on the tasks and use-cases of the actors. A two minute outage is short-term for fixed telephony but long-term for real-time remote control of drones and robots.

“Degradation” means that actors notice reduced performance (e.g. noise during telephone calls, unusual delay in delivery of email messages), but not so much that their tasks or responsibilities are affected.

“Partial unavailability” means severe degradation or unavailability of some aspects of the service, such that actors cannot effectively perform some of their tasks or responsibilities. For example: email can only be sent within the organisation; noise makes telephone calls almost unintelligible; mobile data is unavailable but mobile calls and SMS are not affected. Actors can still perform some of their tasks, but other tasks are impossible or require additional effort.

“Total unavailability” means that actors effectively cannot perform any of their tasks and responsibilities using the telecom service (e.g. phone calls can be made but are completely unintelligible because of extremely poor quality).

“Extremely high” means that if the incident happens the damage will be so large that major redesign of the telecom service is necessary, or the service has to be terminated and replaced with an alternative because repairs are unrealistic.

4.3.5 Assessing all vulnerabilities on a component

The overall vulnerability level of a component is defined as the worst vulnerability for that component. If some of the vulnerabilities are not assessed (no frequency or impact have been set on them), they will not contribute to the overall vulnerability level. It can thus be a useful time-saver to skip assessment of unimportant vulnerabilities.

It is very important that all vulnerabilities with High and Extremely high impact are assessed fully. This is true even when their Frequency is low.

4.4 Expand unknown links

When an unknown link receives an overall vulnerability level of Ambiguous or Unknown, the analysts must decide whether or not to expand the node. Expansion means that the internal make-up of the node is examined; the unknown link is removed from the diagram, and its constituent parts are added to the diagram as individual equipment items, wired and wireless links, and possibly further unknown links. Expansion adds more detail to the model, and results in additional diagram components. The vulnerabilities to these new components must also be analysed, as for any other diagram component.

It is not always necessary to expand unknown links. If the analysts think that the effort involved in expansion is too large, or that it will not lead to more accurate or insightful results then expansion should be omitted.

4.5 Review

When all components have been analysed, a review must take place. All analysts must participate in this review. The purpose of the review is to detect mistakes and inconsistencies, and to decide whether the Single Failures Analysis stage can be concluded.

If any of the components has an overall vulnerability level of Ambiguous or Unknown, the analysts must decide whether or not to conduct further investigation, in order to assess the vulnerabilities to that node with greater certainty. If the analysts think that the effort involved is too large, or that it will not lead to more accurate or insightful results then the component should be left as is.

If the analysts decide to redo some part of the Single Failures Analysis stage, then they should again perform a review afterwards. This review may be omitted when the analysts agree that all changes are minor.

5 Stage 3 — Common cause failures analysis

Determine and analyse common cause failures.

A common cause failure is an event that leads to the simultaneous failure of two or more components. For example: two cables in the same duct can both be cut in a single incident; multiple equipment items may be destroyed in a single fire.

For a common cause failure to happen, the affected components must be within range of each other, according to a critical property. For physical failure events such as fire and flooding, this property is geographical proximity: the components must be sufficiently close to be affected simultaneously. For configuration mistakes it is the similarity in maintenance procedures. For software bugs it is whether related firmware versions are used, regardless of geographical distance. Other events may have different critical properties.

For each failure scenario, the critical property has a maximum effect distance. Two equipment items can only be affected by a minor fire when they are in the same room; for a major fire the effect distance is larger, but still limited to perhaps a single building. Flooding has a much larger effect area, and two components must be further apart to be immune from flooding as their common failure cause.

In stage 3 you will make groups of components that fall within the same range of a critical property. You will do this for each vulnerability separately. For each cluster you will then assess the Frequency and Impact of a common cause failure affecting the components in that cluster. The clusters and their assessments will be recorded in the Raster tool. The result is an improved and refined risk assessment.

The Common Cause Failures Analysis stage consists of the following steps:

1. Create clusters
2. Analyse each cluster
3. Expand unknown links
4. Review

5.1 Create clusters

The Raster tool automatically lists each vulnerability in use, provided that that vulnerability occurs for at least two components. For each such vulnerability, the analyst must create clusters based on the critical property.

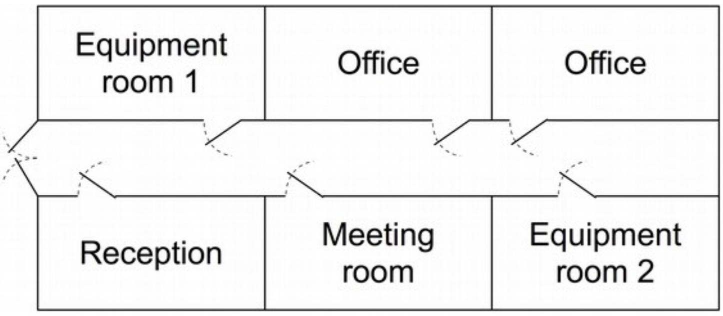
> Example: clusters based on *geographical proximity* can be used for fire, flood, power outage, cable breaks, and radio jamming (per frequency band).
> Clusters based on *organisational boundaries* can be used for equipment configuration, ageing, and software bugs.

Initially, the Raster tool places all components that have the same vulnerability in a single cluster. Based on the effect distance of failure scenarios further subdivisions can be made, such that:

- each cluster represents a class of failure scenarios that are similar in location and effect area.

- a failure scenario for a cluster can never affect components outside that cluster.
- any two components in the same cluster may be affected by the same failure scenario simultaneously.

It is possible for a larger cluster to entirely include a smaller cluster. Clusters may thus be nested. All nodes in a subcluster are members of their parent cluster as well.



For example, the figure to the right shows an office floor plan with two equipment rooms. Three possible clusters are:

1. Equipment room 1 – small fires, affecting components in equipment room 1 only.
2. Equipment room 2 – small fires, affecting components in equipment room 2 only.
3. Entire office – large fires, affecting all components in all rooms.

Cluster 3 then contains subclusters 1 and 2. Note how each cluster is specific to one vulnerability (fire), and covers scenarios that have the same location and effect area.

Chapter 11 describes how the Raster tool can be used to create clusters.

5.2 Analyse each cluster

To analyse a cluster the two factors Frequency and Impact must be assessed. This is done in the same way as for single failures (see section 4.3).

In this stage, the factor Frequency reflects the likelihood that *two or more* components in that cluster are affected by the same threat event. The factor Impact still indicates the overall effect on the telecom service, when the threat event leads to an incident.

The Raster tool will automatically compute the vulnerability level of any parent clusters, including the top level vulnerability.

5.3 Expand unknown links

When a cluster containing unknown links receives an overall vulnerability level of Ambiguous or Unknown, the analysts must decide whether or not to expand those unknown links. This is analogous to expansion in the Single Failures Analysis stage (see section 4.4).

Note that it is not always necessary to expand unknown links. If the analysts think that the effort involved in expansion is too large, or that it will not lead to more accurate or insightful results then expansion should be omitted.

Expansion adds new components to the diagram. These new components need to analysed for single failures. This means that part of Stage 2 needs to be redone for these components. It also means that some clusters receive new member nodes. The analysis of these clusters must be revisited.

5.4 Review

During the final review all analysts must discuss the results of the analysis of single and common cause failures. Special care must be taken to ensure that all assessments are consistent. The next stage must only be started when all analysts agree on the analysis results.

If any of the clusters has an overall vulnerability level of Ambiguous or Unknown, the analysts must decide whether or not to conduct further investigation, in order to be able to assess the common cause failures within that cluster with greater certainty. If the analysts think that the effort involved is too large, or that it will not lead to more accurate or insightful results then the component should be left as is.

If the analysts decide to redo major parts of the common cause failures analysis, then they should perform another review afterwards.

6 Stage 4 — Risk evaluation

Prioritise and evaluate risks, and make treatment recommendations.

When all single and common cause failures have been analysed, a list of the most serious risks can be made. The Raster tool assists the initial effort for this stage. Quick wins can be determined automatically, and simple “what if” analysis is available.

During this stage you make a judgement of which risks you consider to be too large. You write down arguments for your choice and propose risk treatments. You take into consideration both your assessment of vulnerabilities that affect the availability of telecom services and your expectation of reactions of other stakeholders to risk treatments. The result is a report to the sponsor, outlining, explaining and justifying your recommendations.

The Risk Evaluation stage consists of the following steps:

1. Determine longlist
2. Reduce longlist to shortlist
3. Make treatment recommendations, considering social risk factors
4. Prepare final report

6.1 Determine longlist

Based on the information presented by the Raster tool (see section 12), a longlist of the most serious risks must be compiled. These risks are:

- the combination of a single vulnerability and a single component, such as “power failure at the PABX”, or
- the combination of a single common cause failure vulnerability and a single cluster, such as “fire at equipment in the facilities room”.

It is up to the analysts to judge which risks are serious enough to be placed on the longlist. However, the list should include the “quick wins” reported by the Raster tool (see section 12.1). Quick wins are those vulnerabilities that by themselves determine the overall vulnerability level of a component. Reducing that vulnerability would immediately reduce the overall level.

Other good candidates for inclusion on the longlist are those risks that were computed as Extremely high or High, as well the risks that were computed as Ambiguous or Unknown.

6.2 Reduce longlist to shortlist

The longlist must be prioritised. Prioritisation requires more information than can be found in the diagrams and vulnerability assessments. For example, information on control relationships between components, or information about redundancy, cannot be found in the diagrams but is very important for risk prioritisation. Also, telecom services are not all equally important. Therefore, a risk that was assessed as “high” occurring in a service that is useful but non-essential may be listed below a risk that was assessed as “medium” to a vital service. The priority may further be affected by the service acting as backup to another service, or having fallback options itself.

All analysts must collectively examine each risk on the longlist. Based on consensus, risks may be raised or lowered on the list, or may be removed altogether. The result of this process is a prioritised shortlist of risks for which the analysts agree that risk treatment is warranted.

6.3 Make treatment recommendations

It is not the responsibility of the analysts the decide on how risks on the shortlist will be treated. The sponsor or decision maker will be responsible for these measures. However, the analysts do have the responsibility for providing them guidance, and to make reservations for the uncertainty in their assessments and limits to their knowledge.

For each risk on the shortlist, the analysts must give risk treatment recommendations. It is impossible to give a procedure for this, as the suitable treatment for a risk depends very much on the type of service, the nature of the risk, and the circumstances of the case organisation.

6.3.1 Select risk treatment option

In general, four general risk treatment options exist:

1. **Avoid.** Remove the risk completely (proaction), or discontinue the use of the component or service altogether. Proaction means eliminating structural causes of accidents to prevent them from happening in the first place (e.g. avoiding radio interference by replacing a wireless link by a wired link). When discontinuing an entire service, an alternative service will often be available. However, you should be careful to replace a service with known risks for a new one with unknown risks.

   Even when no alternative is available it may still be worth considering discontinuing use of the telecom service when the risk cannot be avoided. Rather than using a service that may fail unexpectedly, it may be preferable to not use the service at all to avoid unpleasant surprises at inopportune moments during crisis response.

2. **Reduce.** Make the risk more acceptable, by reducing either its likelihood (frequency) or impact. These activities encompass prevention and preparation. Prevention means taking measures beforehand that aim to make accidents less likely, and to limit the consequences in case incidents do occur (e.g. by imposing smoking restrictions and using fire-retardant materials). Preparation means ensuring the capacity to deal with accidents and disasters in case they do happen (e.g. by holding regular fire drills).

3. **Transfer.** Pass the risk to another party. Typical examples of risk transfer are insurance, or maintenance contracts whereby faulty equipment is replaced with spares on short notice. Risk transfer in effect buys certainty, by transferring the uncertainty to another party in return for payment.

4. **Retain.** Accepting the risk, in an informed decision. Reasons for accepting risks may be that other options would be too costly, that the likelihood is deemed to be very low, or simply the lack of suitable alternatives. In all cases it is much preferable to knowingly accept a risk rather than being confronted with it.

Factor	*Description*
Artificiality, immorality	“Unnaturalness” of risk sources.
Benefits	Tangible and intangible beneficial effects.
Blame	Responsibility for damages attributable to some actor.
Catastrophic potential	Fear of sudden, disruptive, large effects.
Children	Amount of risk exposure faced by children in general.
Familiarity	Extent to which the risk is perceived as common and well known.
Fear	Characterises the amount of fear.
Institutional control	Close, effective monitoring of risks by authorities, with the option of intervention when necessary.
Media exposure	Amount of attention by (social) media.
Mobilisation	Potential for protests and active opposition.
Personal control	Level of control that an individual stakeholder can exercise.
Violation of equity	Discrepancy between those who enjoy the benefits and those who bear the risks.
Voluntariness	Amount of free choice an individual has in being exposed to the risk.

Table 6.1: List and description of social risk factors.

6.3.2 Assess social risk factors

The draft treatment of risks on the shortlist may lead to criticism by other stakeholders. The opinions of these stakeholders must be considered before final treatment recommendations are formulated. Otherwise, decision makers may unexpectedly have to deal with societal opposition, possibly forcing them to opt for a sub-optimal treatment that is nevertheless more acceptable to external stakeholders. Analysts must therefore assess additional risk factors that influence risk perception and risk acceptance by third parties. See Table 6.1.

Artificiality applies to situations where people oppose a technology because it is unnatural. For example, electromagnetic radiation from mobile telephony base stations is more often considered 'harmful', whereas natural sunlight is more often considered 'healthy'. However, there is scientific consensus that ill effects from electromagnetic radiation have not been demonstrated, whereas the incidence of skin cancer is cause for serious concern. Related to this issue is that of immorality. Immorality play a role when technological solutions go against people's ethical or moral principles.

Benefits can counterbalance the availability risks on the shortlist. Risky situations can be acceptable when the (perceived) benefits outweigh the (perceived) risks. For example, construction of a high broadcasting tower may meet with less opposition if it will be used for emergency communications instead of entertainment broadcasts.

Blame can sometime be apportioned to some actor (e.g. a telecoms operator), but natural risks cannot be blamed on anyone in particular. Risks without blame are often more acceptable than risk caused by some explicit actor.

Catastrophic potential makes risks less acceptable. The menace of wide-spread, large-scale destruction, regardless of likelihood, makes risks less tolerable. On the other hand, risks that have a small chronic effect over a period of time are often more easily accepted.

Children influence risk perception, sometimes in dramatic ways. People have strong feelings when children are affected by risks.

Familiarity with a risk may lead to complacency. The reverse is also true: novel risks may be less tolerable, simply because they are less well-known.

Fear is a general factor, related to catastrophic potential and familiarity. Strong feelings of fear decrease risk acceptance.

Institutional control can reassure people that risks are handled diligently. Sufficient trust in institutions is a prerequisite. When trust in institutions is low, risks will be perceived to be higher.

Media exposure can lead to increased perception of likelihood. Few people experience risks first-hand, and wide coverage by broadcasting or social networks can increased risk perception.

Mobilisation potential is relevant to decision makers. The 'nimby' phenomenon (“not in my backyard”) reflects mobilisation by nearby residents. Risks may provoke wide-spread and vocal opposition, making them less acceptable to decision makers.

Personal control refers to the amount of influence individuals can exert over the risky situation. For example, the risk of disturbances in communication are more acceptable when the user has the ability to control the device and participate in communication, instead of having only the passive ability to listen.

Violation of equity occurs when the benefits and the adverse effects are unevenly distributed. Opposition will be strong if the beneficiaries do not experience adverse effects at all.

Voluntariness is related to personal control. For example, people can choose whether or not to use a mobile phone, but construction of a mobile antenna mast in their neighbourhood is imposed upon them. Lack of voluntariness makes risks less acceptable.

6.3.3 Review the shortlist

The analysts must review each risk on the shortlist, to determine whether social risk factors may have a significant impact. This consists of the following steps:

1. Predict in what forms the risk factor would be expressed for various external stakeholders. For example, would it lead to a tarnished public image, reduced funding, or perhaps active opposition?
2. Assess the influence that this would have on the ability of decision makers to defend their choice of risk treatments. Can they easily deflect criticism, or will they be forced to select an alternative treatment?
3. Assess how the influence of the risk factor could be mitigated in advance, for example by informing stakeholders in advance, ask for their approval, or having them participate in a monitoring and oversight body.

If necessary, risk prioritisation should be adjusted and additional or different risk treatments should be recommended.

6.4 Prepare final report

The analysts have now collected all information for the final report. Not only can they present a prioritised shortlist of most serious risks with treatment recommendations, but they can also provide arguments for their proposals.

This final report must be reviewed by all analysts, and it must be approved by consensus before it is presented to the sponsor. The study is thereby concluded.

A suggested outline of the final report is shown below.

1. Executive summary to the final report.
2. About the case organisation (internal scope):
    a. Position within wider system of stakeholders.
    b. Tasks.
    c. Responsibilities.
    d. Telecom services used, together with their role and purpose.
    e. Main actors.
3. About the environment of the case organisation (external scope):
    a. Disaster scenarios.
    b. External parties with whom the main actors may communicate.
4. Roles and stakeholders
5. Telecom services
    a. Diagram with explanation (once for each service)
    b. Important risks (single failures and common cause failures)
6. Risk shortlist, with for each risk:
    a. Description
    b. Relevant social risk factors
    c. Justification for risk priority, uncertainty, and limits to knowledge
    d. Recommended risk treatment
7. Conclusions and recommended actions

Appendices:

8. Glossary
9. Reports of single failures
10. Reports of common cause failures

7 Executing the Raster method

Practical guidelines for execution of the Raster method.

7.1 Team composition

Three factors influence the choice and number of analysts.

1. To apply the Raster method to an organisation, expertise from various fields of study is essential. Analysing threats to telecom service components requires in-depth knowledge of telecoms engineering, crisis management, political and legal issues, and the preferences of external stakeholders. No analyst can be expected to be expert in all these fields.
2. Raster requires analysts to make assessments about uncertain scenarios, often without access to all desired information. This inevitably means that assessments are partly subjective. By including several analysts from different backgrounds, the amount of subjectivity can be kept in check.
3. Several steps in the Raster method call for consensus. When the group becomes too large, reaching consensus will be time consuming.

These factors indicate that the group of analysts should not be too small, but also not too large. The group should include experts from different fields and backgrounds, and should not exceed 10 persons.

Some analysts may opt to not actively participate in the gathering of information and analysis of vulnerabilities. A core group of analysts will then perform most of the tasks. However, it is essential that all analysts participate in all reviews, and agree to the stage results and final report.

7.2 Managing work sessions

Before a Raster project can start, all analysts must be sufficiently familiar with the method. Each analyst should have received a copy of this manual well in advance. Unless all analysts are familiar with the method, an introductory session should be held in which someone who is well acquainted with the method shows its key activities using a small mock-example.

To speed up execution of the Raster method some activities can be performed in parallel. However, the more the analysts break into separate groups, the more they will need to coordinate the integration of their intermediate results later on. After all, the Raster method leads to a single final report, on which all analysts need to agree.

7.2.1 The recorder

During stages 2 and 3 one of the analysts should be appointed as recorder. The responsibility of the recorder is to record the diagrams and the assessments of vulnerabilities to components using the Raster tool. The recorder should use a computer connected to a projector, so that all analysts in the room can view a common, central display of the tool. The recorder may also act as a moderator during the assessment.

Because the recorder notes all assessments, he or she will be the best placed to detect inconsistencies in assessments. The recorder should take special care to notice inconsistent scores between components, and bring these up for discussion. For example, if some vulnerability is scored as Medium in one component but as Low in another, similar component, the group should discuss whether one of these scores may have to be adjusted.

In follow-up sessions the recorder may find it useful to distribute printouts from the Raster tool for reference.

7.2.2 Stage 1 — Initiation and preparation

If some of the analysts are not yet familiar with the method, the group should not be divided. Otherwise, two groups could be formed:

1. one group to identify telecom services and actors, and
2. one group to describe disaster scenarios.

This division should only be made if the analysts expect that it will save a large amount of time. Because the Stage 1 results will be referenced throughout the study (in stages 2, 3, and 4) it is important that all analysts are intimately familiar with its contents, which may not be the case when the group is divided.

7.2.3 Stage 2 — Single failures analysis

For analysis of diagrams, the analysts may divide themselves into groups, each group analysing their own subset of telecom services. Before the group is split one or two services should first be analysed together, so that all analysts share a common approach and procedure. The groups must then remain in close contact, as components may be present in more than one telecom service and must be assessed in a consistent manner.

It may not be possible to complete the analysis in a single work session. After the initial diagram has been created and analysed, the analysts may decide to expand unknown links, or decide to do further investigations. It may thus require a number of work sessions to complete the single failures analysis.

7.2.4 Stage 3 — Common cause failures analysis

Common cause failures are assessed for the project as a whole, and not for individual telecom services. It is therefore not possible nor useful to divide the analysts into groups.

As with single failures analysis, multiple work sessions may be necessary to complete the analysis of common cause failures.

7.2.5 Stage 4 — Risk evaluation

All analysts must participate in creation of the longlist and shortlist. Most likely this can be completed in a single work session. Based on this shortlist social risk factors must be assessed. This assessment may require further investigation, and it may not be possible to complete this in a single work session. The analysts may decide to break into groups, each group analysing some risks from the shortlist. The first few risks should again be analysed together, before the group is split. As with all reviews, it is essential that the assessment of social risk factors be reviewed by the entire group of analysts.

The collation of material into a final report should be done by a small team of editors. Much of the Stage 1 report can be reused, and printouts from the Raster tool can be used for the appendices suggested in the template in section 6.4.

8 Raster tools

Facilitate execution of the Raster method.

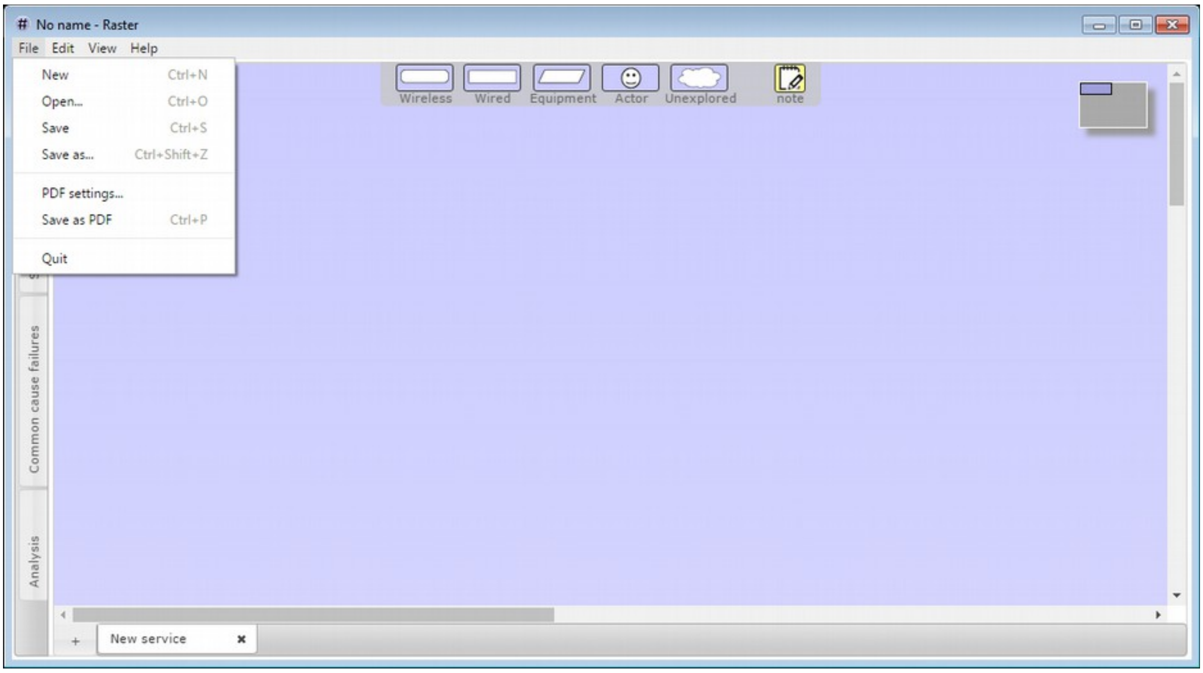
To assist in performing risk evaluations using Raster, two free tools are available. See the inside of the front cover of this booklet for download locations.

The first tool is a standalone MacOS or Windows application that edits Raster project files stored on a local or network drive. The second tool is web based. It is to be installed on an intranet server and allows access to shared projects from any web browser on the local network. In both tools, a *project* contains the complete risk assessment for a single organisation. Typically, a project encompasses several telecommunication services.

With minor differences, both tools work in the same way. The most obvious difference is that the standalone tool uses a menu bar to manage project files and options; the intranet tool uses a Library and Options panel instead. Sections 8.1 and 8.2 describe the specifics of the standalone and intranet tool respectively. The rest of the chapter and the subsequent chapters apply to both tools.

8.1 Working with the standalone tool

The standalone tool operates on project files stored on local or network drives. Project files are opened, edited and saved very much like how you edit text documents or spreadsheets. Pictured below is the Windows version of the tool.



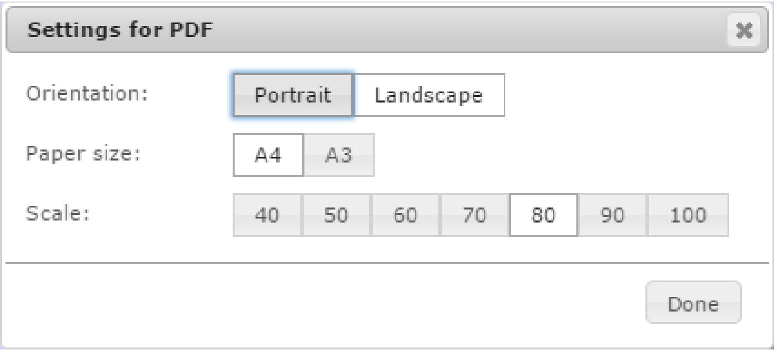
8.1.1 File menu

The File menu is used so open, save, and print project files. You can:

- *open* and *save* project files (Open, Save, Save as).
- *create* a new, blank project file.

It is not possible to print from the tool directly, but you can save your current view as a PDF file. To save a diagram, its list of single failures, the list of common cause failures, or the tables in the Analysis view, use the option “Save as PDF” in the File menu. Before you save, review the PDF settings. You can:

- choose *orientation* (Portrait or Landscape). Landscape (wide) orientation is often best for diagrams; Portrait (tall) is often best for all other views.
- choose *paper size*. Use A3 for large diagrams, A4 for any other views.
- choose the *scale*. 80% to 100% is often best, but to fit large diagrams on a single sheet you my have to go down to 40% scaling.



Settings for PDF

Orientation: Portrait | Landscape

Paper size: A4 | A3

Scale: 40 | 50 | 60 | 70 | 80 | 90 | 100

8.1.2 View menu

The View menu is used to change layout and preferences. You can change:

- *Labels:* The colours that are associated with labels can either be hidden or shown. When hidden, nodes are always painted in plain black and white, as if no label was assigned to them. Hide the label colours when you find this too distracting, or before saving to a black and white PDF document.
- *Vulnerability levels:* The size of the vulnerability level indicators (see 9.3.3) can be switched between large and small, or they can be hidden entirely.
- *Find nodes:* See 8.4.
- *Zoom:* increase or decrease the size of diagrams or text. For large diagrams it may be useful to shrink the text and images to fit more of them on the screen.
- *Full screen:* expand the tool to make it use all available screen space.

8.1.3 Help menu

Use the Quick guide to see the most important hints on using Raster; see 8.5.

8.1.4 Edit and Window menus

The Edit menu contains the usual items. The menu items apply to text fields only. On MacOS, the Window menu contains the usual items.

8.2 Working with the intranet tool

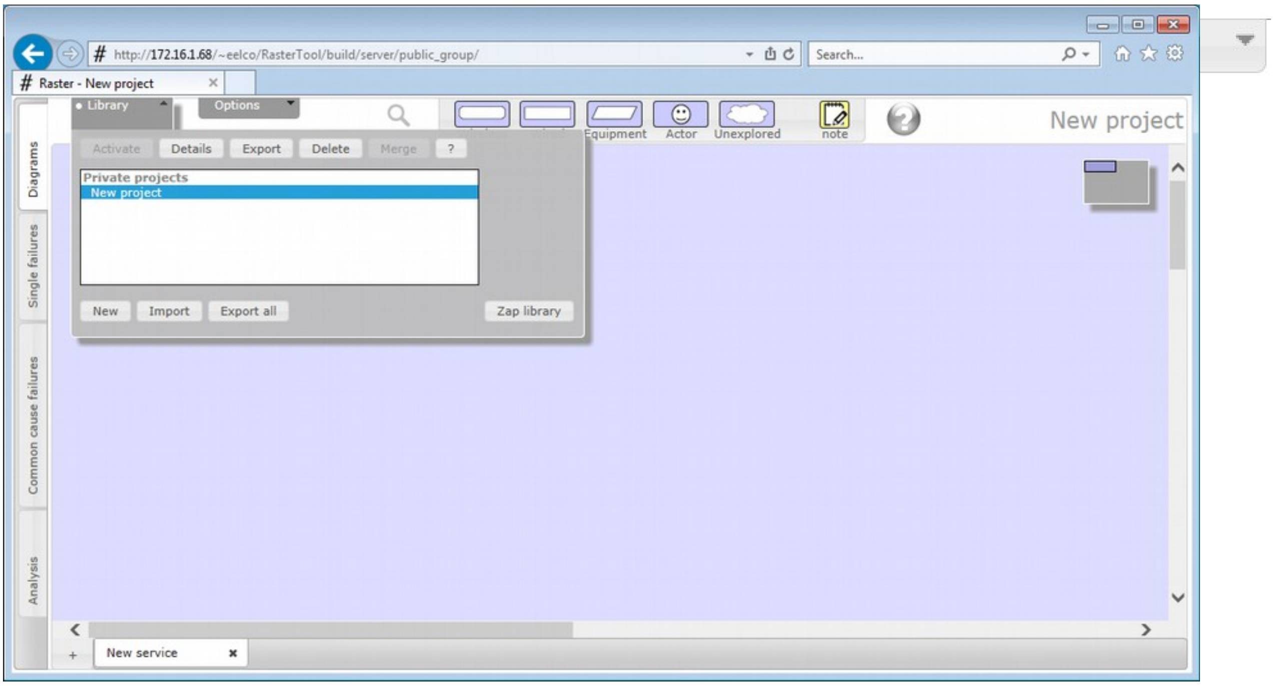
The intranet tool can handle multiple projects, but only one can be active at any time. Multiple analysts can work on the same project simultaneously; each change is shared with other members automatically.

The editing that you perform is recorded instantly. This means that if you close your browser window none of your work is lost. When you visit the tool's URL again, the state of your workspace will be fully restored. It is therefore also not necessary to save your work, or to open a file before commencing work.

Projects can be private or shared. *Shared projects* can be edited by multiple people at the same time. Any changes you make to a shared project are immediately propagated to all other people currently editing the same project; any changes that they make are immediately reflected in your own browser.

Private projects are not visible to other people, and are never stored on the server. When you work on a private project and visit the tool's URL from a different machine, or even using a different browser on the same machine, your previous work is not restored. This does not mean that your work is lost; it is tied to one particular browser. To transfer a private project between machines or browsers, or if you wish to share your projects with a co-worker, you must export that project. By exporting, all data of the project is saved into a project file, which can then be stored and transferred as any other file. Exporting is explained in the section 8.2.1. Likewise, such a project file can be imported using the Import function. After importing, any changes will again be recorded instantly. However, they will not affect the file; the file is not modified until you decide to export again.

Pictured below is the intranet tool, running in Internet Explorer 11.



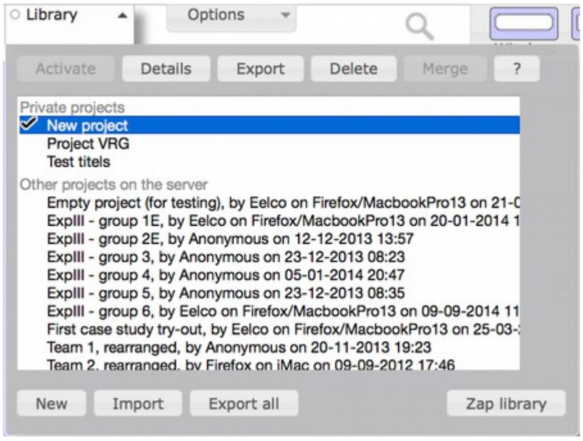
There are two panels to control the intranet tool: the Library panel and the Options panel. The panels are normally hidden, but can be opened using one of the two buttons along the top of the workspace. You can:

- *open* the panel by clicking its button.
- *close* the panel by clicking the button a second time.
- *close* the panel by clicking anywhere outside the panel.
- *swap* between panels. When one panel is open, hovering over the other button will immediately open that other panel.

8.2.1 The Library panel

The Library panel shows a list of all projects that are currently available for viewing and editing. The project that is currently active is indicated with a checkmark.

The list of projects is divided into three sections: your private projects, shared projects that you have worked on, and other shared projects.

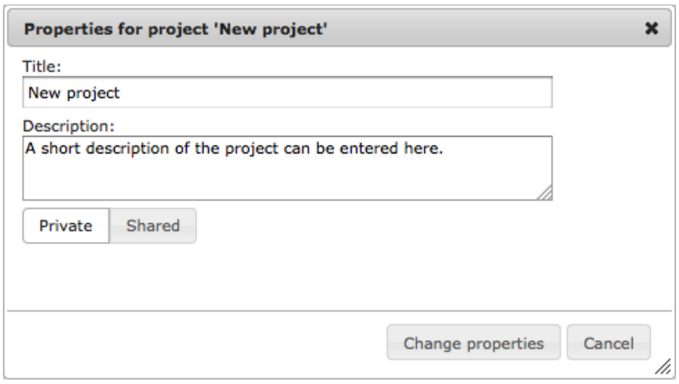


Private projects
✓ New project
Project VRG
Test titels
Other projects on the server
Empty project (for testing), by Eelco on Firefox/MacbookPro13 on 21-0
ExpIII - group 1E, by Eelco on Firefox/MacbookPro13 on 20-01-2014 1
ExpIII - group 2E, by Anonymous on 12-12-2013 13:57
ExpIII - group 3, by Anonymous on 23-12-2013 08:23
ExpIII - group 4, by Anonymous on 05-01-2014 20:47
ExpIII - group 5, by Anonymous on 23-12-2013 08:35
ExpIII - group 6, by Eelco on Firefox/MacbookPro13 on 09-09-2014 11
First case study try-out, by Eelco on Firefox/MacbookPro13 on 25-03-
Team 1, rearranged, by Anonymous on 20-11-2013 19:23
Team 2, rearranged, by Firefox on iMac on 09-09-2012 17:46

The highlighted project can be acted upon using the row of buttons above the list.

You can:

- *see the description* of a project, by hovering the mouse pointer over it.
- *activate* the highlighted project (to start viewing and editing it), by clicking the "Activate" button. You can also *double-click* the project in the list.
- *save* the highlighted project, by clicking the "Export project" button. The project will be downloaded as a file; the filename consists of the project name and the current date and time.
- *remove* the highlighted project, by clicking the "Delete" button. If the last project in the list is deleted, it will be replaced with a blank project.
- *merge* the highlighted project into the currently active project. All services of the highlighted project will be re-created as services of the active project.



Properties for project 'New project'

Title:
New project

Description:
A short description of the project can be entered here.

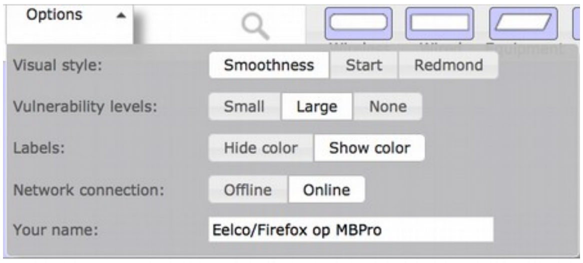
- *change properties* of the highlighted project by clicking the "Details" button. Projects have a name, an optional free-text description, and a sharing status (private or shared).

Below the project list there are buttons for actions that operate on the library itself:

- *create* a new project, using "Add empty project".
- *import* a previously saved file, using the "Import from file" button.
- *save all* projects using the "Export entire library" button.
- *erase* all services, diagrams and projects, using the "Zap library" button. This will clear *all* information stored in this web browser. Unless you had previously exported your projects onto other storage, you will lose all your work.

Exporting the entire library is not only a convenient way to transfer your work between browsers or machines, but is also useful to create a snapshot of Raster in case of bug reports. Sometimes the tool may show "weird" error messages. Noting down the error and immediately saving the state of your work by exporting the entire library will provide valuable information to improve the tool.

8.2.2 The Options panel



Visual style: Smoothness | Start | Redmond
Vulnerability levels: Small | Large | None
Labels: Hide color | Show color
Network connection: Offline | Online
Your name: Eelco/Firefox op MBPro

The options panel provides settings and other preferences.

1. *Visual style*: The appearance of the tool can be modified by choosing one of the three styles provided, named "Smoothness", "Start", and "Redmond".

2. *Vulnerability levels:* The size of the vulnerability level indicators (see 9.3.3) can be switched between large and small, or they can be hidden entirely.
3. *Labels:* The colours that are associated with labels can either be hidden or shown. When hidden, nodes are always painted in plain black and white, as if no label was assigned to them. Hide the label colours when you find this too distracting, or before printing to a black and white printer.

> The preferred size of the vulnerability level indicators and the label colours also affect printing.

4. *Network connection:* The network connection to the server is normally automatically set to either offline (disconnected) or online (connected). You can (re-)enable communication with the server by switching to online.
5. *Your name:* The server stores the name of the last person to modify a shared project, together with the date of modification. Enter your name here; this is purely informational.

8.2.3 Printing in the intranet tool

You can print a diagram, its list of single failures, the list of common cause failures, and the tables in the Analysis view. The print view looks very different from the normal screen display; the tabs, buttons and other user interface elements will not show up in the printed document.

When using Firefox, the scroller is reset to the top-left position and single or common cause failures are expanded just before printing. With other browsers, you may have to do this manually. You can use the “Expand all” function before printing.

When printing the diagrams, it is best to set the paper size to A3 and landscape orientation. A4 paper may suffice for smaller diagrams. The Single Failures and Shared Failure views are best printed using portrait orientation. You may need to shrink the printout to make it fit the paper, using the printing features of your web browser.

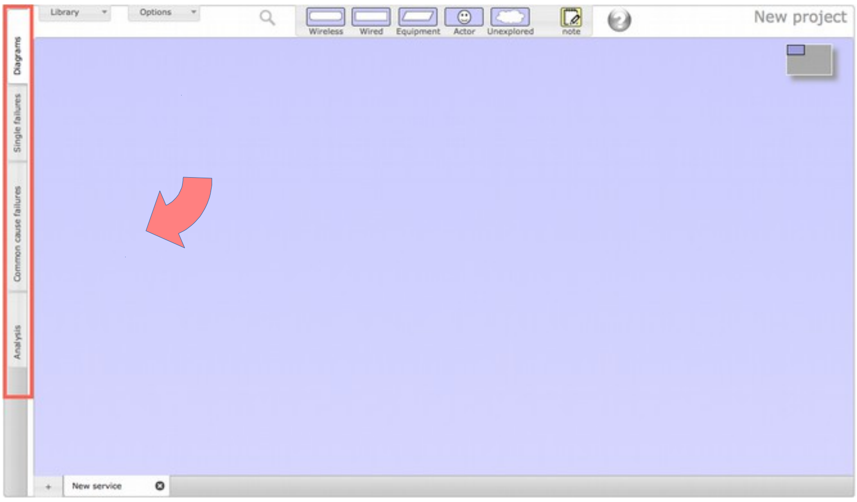
Make sure that the printing of background colours is enabled in your web browser, otherwise the risk classification indicators will all show as white. The option to print background *images* is not relevant; the printed document does not contain background images.

You can use the Options panel to set the size of the vulnerability level indicators and choose whether label colours are printed. These setting apply to both the printed and the on-screen version of the intranet tool.

8.3 Main views

Both the standalone tool and the intranet tool are divided into 4 main views, indicated and selected by the vertical tabs on the left-hand side.

1. **Diagrams** view is used to draw and edit diagrams of telecom services.
2. **Single failures** view is used to assess failures of individual elements.
3. **Common cause failures** view is used to assess common cause failures.

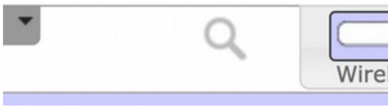


4. **Analysis view** is used to view reports on completed diagrams, and to see the effects of individual vulnerabilities on overall vulnerability levels.

   You can:

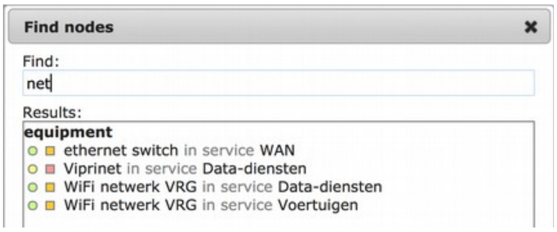
- view a short description of each tab, by hovering (holding the mouse pointer stationary) over the tab.

8.4 Find nodes



When diagrams get larger and the number of diagrams increases, it can become more difficult to remember in which service nodes are located, and what their names were. Use the looking glass icon to call up a search window.

Search results will be presented as you type. The overall vulnerability level (when available, as a coloured square) and label colour (if set, as a coloured circle) will be shown.

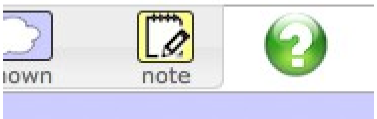


Find nodes ✖

Find:
net

Results:
equipment
○ ■ ethernet switch in service WAN
○ ■ Viprinet in service Data-diensten
○ ■ WiFi netwerk VRG in service Data-diensten
○ ■ WiFi netwerk VRG in service Voertuigen

8.5 Help window



The Help window provides tips and other information on the tool. Open the Help window using the question mark button.

In the “How to use” tab of the Help window you will find a link to the full Raster manual.

8.6 Colour codes

In several locations colours are used to indicate the overall vulnerability level for a node. If size permits, a letter is also shown. The following letter and colour combinations are used:

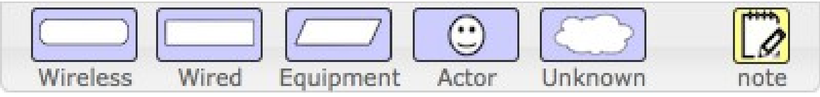
-	Not yet analysed, no assessment has been done yet (white)
A	Ambiguous, the assessors have conflicting opinions (purple)
V	Extremely (very) high, an extreme risk (bright red)
H	High (red)
M	Medium (yellow-orange)
L	Low (green-orange)
X	Unknown, because of lack of knowledge (sky blue).
U	Extremely (ultra) low, the risk level is negligible or absent (bright green)

9 Diagrams view

Create telecom service diagrams.

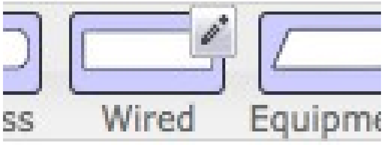
The centre of this area is occupied by the workspaces in which telecom service diagrams are drawn. Below this area is a row of tabs, to create an additional service and to switch between services. Above this area you find buttons to activate the Library and Options panels, a row of templates, and the name of the active project.

9.1 Templates



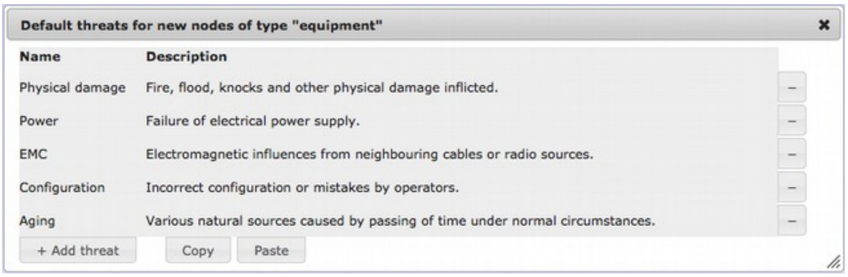
Templates contain default settings for new diagram nodes. You can:

- *view* a short description of the template, by hovering (holding the mouse pointer stationary) over the template.
- *create* new nodes by dragging one of the templates into the workspace.



For the first three elements (wireless links, wired links, and equipment items), you can modify the predefined checklists. Click the edit indicator to open the checklist window for that element type.

9.2 Checklist windows



Default threats for new nodes of type "equipment" ×

Name	Description	
Physical damage	Fire, flood, knocks and other physical damage inflicted.	−
Power	Failure of electrical power supply.	−
EMC	Electromagnetic influences from neighbouring cables or radio sources.	−
Configuration	Incorrect configuration or mistakes by operators.	−
Aging	Various natural sources caused by passing of time under normal circumstances.	−

Wireless links, wired links, and equipment items each have a list of default vulnerabilities. In the checklist window you can:

- *modify* the name or description of a vulnerability by clicking that item (press Enter/click elsewhere to confirm, press Escape to cancel)
- *remove* a vulnerability, by clicking the minus-button on the right. You will be asked to confirm the deletion.
- *add* a new vulnerability, by clicking the “+ Add vulnerability” button.
- *reorder* the vulnerabilities, by dragging them into the desired order.
- *copy* the checklist, so that you can paste it into a vulnerability assessment for a node.
- *paste* the vulnerabilities of a vulnerability assessment.

The vulnerabilities that you create this way will be used as templates for any new element nodes that you create. Once created, each element node has its own independent list of vulnerabilities. Editing the checklists will not affect existing nodes in any way.

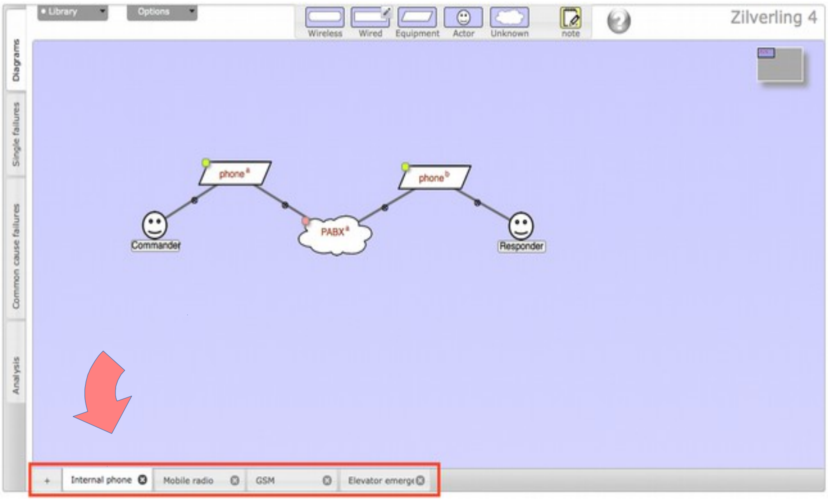
Suppose that you have been working on a diagram and notice the omission of a vulnerability in a checklist. Rather than adding that vulnerability to each node that you have created, you can add it to the checklist with the "+ Add vulnerability" button. To quickly update all existing nodes, you then Copy the list of vulnerabilities. Switch to the Single Failures view, and Paste the vulnerability list into each existing node of that type, and into each unknown link. When pasting, any vulnerability assessments that have been filled in will be preserved. Pasting is a quick way to correct a forgotten checklist vulnerability.

9.3 Workspace

The workspace is the areas where the diagrams for telecommunication services are drawn. A project consists of one or more services. For each service, you can draw a telecom service diagram, and perform vulnerability assessments on nodes.

9.3.1 Service tabs

Each service has a tab at the bottom of the screen.

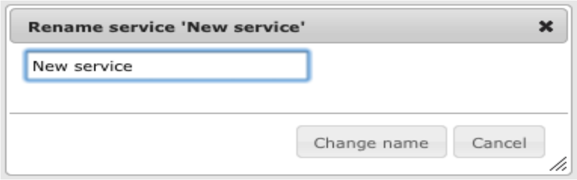


You can:

- *view* the service diagram for a service, by clicking its tab.
- *see* the full name of the service (it will be cut off beyond the close button), by hovering the mouse pointer (keeping it stationary) over the truncated name.
- *remove* a service, by clicking the close button on its tab. Note that you cannot remove the last service of a project. If you try to, the workspace will flash briefly.

- *add* a new service to the active project, by using the plus-button.

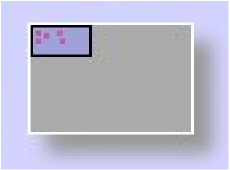
- *rename* a service, by *double-clicking* its name. A popup window will appear, in which you can enter the new name. End by pressing the Enter key, or click the "Change name" button. Cancel by clicking the Cancel button, or press Escape.


Rename service 'New service'

New service

- *re-order* the services, by dragging the tabs into the desired order.

9.3.2 The scroller



The workspace onto which nodes are drawn and connected, is larger than can be displayed on the screen. Use the scroller to change the current view.

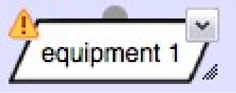
The large grey area of the scroller represents the total available workspace, while the smaller blue rectangle corresponds to the area that is currently visible (the workspace). Each red dot is one of the nodes in the diagram. Each red dot outside the blue rectangle indicates a node that is currently not visible.

With the scroller you can:

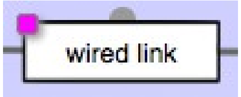
- *move* the visible area, by dragging the blue rectangle around.
- *move* the scroller itself, when it gets in the way, by dragging the grey rectangle around.

> When your diagram gets large, you can use the Zoom In, Zoom Out functions of your browser to fit more of the diagram onto the screen.

9.3.3 Diagram nodes



You create new diagram nodes by dragging them from the templates at the top of the screen. Each node is visually represented as a shape with its name and up to five decorations. Clockwise, starting from the top left corner:

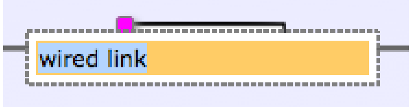


1. The *warning triangle* in the top-left corner indicates that the node has too few or too many connections.
2. The *vulnerability level indicator* in the top-left corner indicates the overall risk level for that node, using a colour. This indicator is hidden when the warning triangle is shown. If you prefer a larger vulnerability level indicator, you can choose one using the Options panel. The larger size contains the first letter of the class name (H for High, M for Medium, etc; see section 8.2.2).
3. The round *connector* at the top middle is used to link nodes together.
4. The *drop-down indicator* in the top-right invokes a menu with actions.
5. The *resize indicator* in the bottom-right allows the size of the node to be adjusted.

With a node you can:

- *view* the warning report, by clicking on the warning triangle. The report is updated immediately when the status of the node changes; you do not need to click the triangle again to refresh the report.
- *move* the node to another location on the workspace, by dragging it around.

> There are two ways to move more than one node at the same time. Hold the shift key while dragging a node to move all nodes in the diagram. Alternatively, create a selection (see 9.3.8), and drag the selection rectangle to move the selected nodes only.

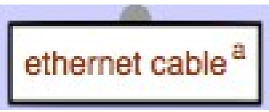


- *rename* the node, by clicking its title. Note that the area becomes orange when you hover the pointer over the title. Confirm by clicking somewhere outside the workspace, or press Enter. Cancel the action (that is, revert to the current title) by pressing Escape.
- *resize* the node, by dragging its resize handle. You can increase the size up to twice the normal size.
- *call up* the menu, by clicking the drop-down indicator. Alternatively, you can right-click anywhere on the node. Click the desired menu item; click anywhere outside the menu to cancel.
- *view* an explanation of the vulnerability level, by hovering the mouse pointer over the coloured vulnerability level indicator.

Instead of clicking the drop-down indicator, and then clicking the desired menu item, you can also press and hold the mouse button over the drop-down indicator, move the pointer to the desired menu item, and release the mouse button over that menu item.

9.3.4 Node classes

Nodes that are very similar can be made into a *node class*. Node classes are marked by a dark red colour. All nodes of a class share a single assessment of vulnerabilities. To be able to distinguish individual nodes in a class, each node is automatically assigned a letter, shown to the right of the name. This letter can be changed to something more meaningful using the “Change suffix” option of the node menu.



You create a node class by giving one node the same name as another node of the same type. Both nodes will be put into the class. You can add as many nodes as you need, again by renaming nodes to the name of the class.

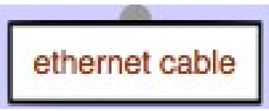
Warning: by placing a node in a node class you discard all vulnerability assessments of that node. The node will adopt the vulnerability assessments of the class.

Note that a node class can span more than one service; nodes of the same class can appear within more than one service (of the same project). There are no actor classes.

When a member node of a node class is renamed, it will cease being a member and will become an individual node again. To rename all members of the node class collectively, use the “Rename class” option of the node menu.

9.3.5 Identical nodes

Within a service each physical component can only appear once. The same physical component may however appear in two different services. To indicate this, use the following procedure.



First, create a node class by giving the nodes the same name in each service diagram. Then, to mark the node class as a single physical component instead of two similar “copies”, use its popup menu item “Make single”. Note that the title of single nodes is still shown in red, but that the superscript letter is omitted.

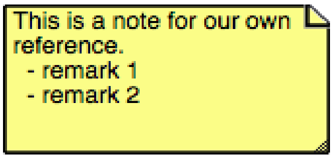
'Make single' can only work when the nodes in the class are in separate services. When the node class has more than one node in a service, the node will flash to indicate that it cannot be converted to a single node.

To revert to a node class, use the popup menu item “Make class” on a single node.

9.3.6 Notes

For your convenience notes can be added to a diagram. You add a note by dragging its template onto the workspace, just as you do for diagram nodes.

Notes can contain any text. You can resize notes, change their text, duplicate them, delete them, and label and colour them in the same way as for diagram nodes.

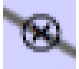

This is a note for our own reference.
- remark 1
- remark 2

9.3.7 Connecting nodes

Nodes can be connected by dragging the connector (the round decoration at the top of the node) onto another node. If no connection is possible (for example, actors cannot be connected directly to a wireless link), both nodes will flash briefly and no connection will be made.

With connections you can:

- *connect* the node to another node, by dragging from its connector at the top. The connector will enlarge when the mouse pointer hovers over it.
- *disconnect* two nodes, by clicking its disconnect button.



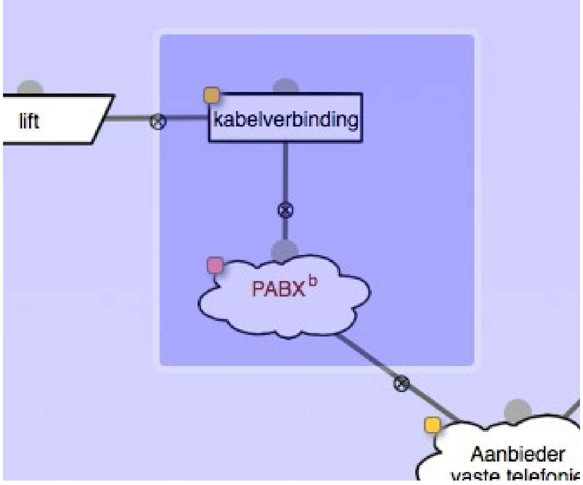
Connections cannot be moved; they automatically follow the two nodes that they connect.

It is possible to have more connections than allowed by the connection rules for that node type (see section 2.2). This may be useful during editing You will need to remove extra connections later on, for the diagram to be valid. Meanwhile, the node will show a warning triangle.

9.3.8 Selecting nodes

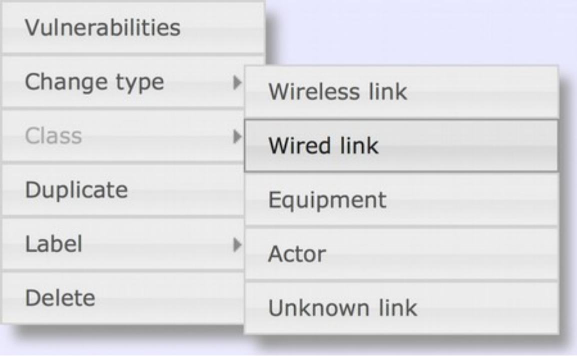
A set of nodes can be selected, and moved or deleted as a group. Click and drag anywhere on the workspace outside a node to create a selection. While dragging, a blue rectangle indicates the current selection. You can:

- *delete all nodes* in the selection, by *right-clicking* the selection rectangle and choosing “Delete selection” from the popup menu.
- *label all nodes* in the selection, by right-clicking the selection rectangle and choosing the appropriate label from the menu.
- *move all nodes* in the selection, by dragging the selection rectangle itself.



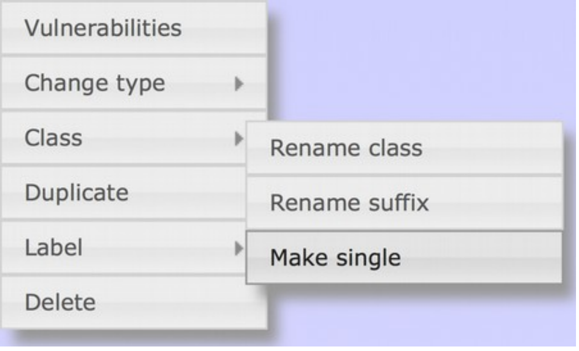
9.3.9 The node menu

The popup menu allows several operations to act on a node:



- *call up* the vulnerability assessment window (see section 9.3.11).
- *change* the type of the node (e.g. from a wireless link into a cloud).
- For nodes that belong to a node class:
  - ▫ change the name of all nodes in the node class. Renaming a single member will make that node fall out of the node class. Use this menu item to rename all member nodes collectively.
  - ▫ *change the suffix* from the default of a single letter ('a', 'b', 'c', …) to something more meaningful, such as an abbreviation of the location of the component.

  - *change* the type of the node class from a single identical node into a collection of similar nodes, and vice versa (see 9.3.5).
- *duplicate* the node. This will create a node class.
- *label* the node, using one of the 7 available labels (see 9.3.10).
- *delete* the node.



Note that the vulnerability assessments will not be preserved when changing the node type. Typically, it is not possible to preserve vulnerability assessments, as nodes of different types tend to have very different default vulnerabilities.

> Changing the type to something different and back again is a quick way to reset all vulnerability assessments for that node.

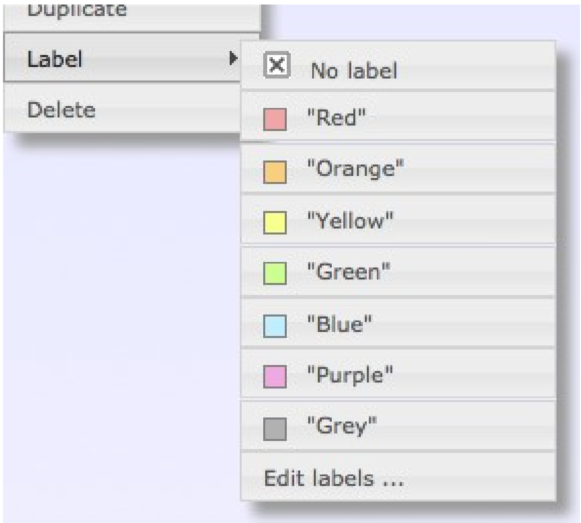
Changing the node type can be used to correct a mistake (for example, you intended to create a wired link but accidentally used the rounded rectangle, which is for wireless links).

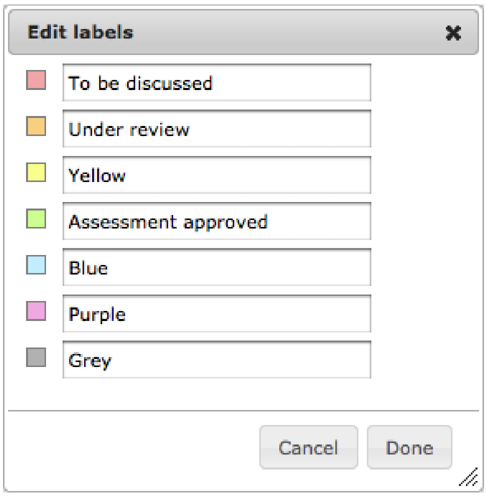
> Changing node types is also useful to convert an equipment item into a cloud, if you notice during your analysis that the situation is more complex than you previously thought.

9.3.10 Node labels

You can use labels to organise nodes. For example, you can label nodes to mark them as 'under review' or to record additional information that is not normally part of the diagrams, such as ownership, responsibility or physical location. Labels are optional, and have no relation to vulnerability assessments. You can hide or show labels in the Options panel (section 8.2.2).

Labelling nodes can be useful when clustering nodes in common cause failures view (section 11.3).




Edit labels ✖

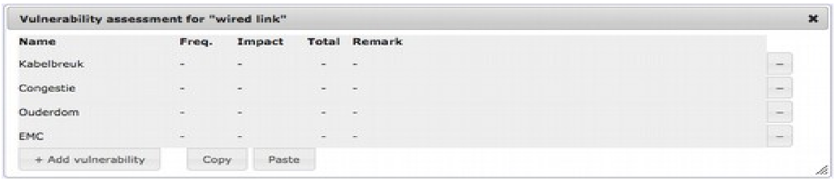
🟥 To be discussed
🟧 Under review
🟨 Yellow
🟩 Assessment approved
🟦 Blue
🟪 Purple
⬛ Grey

To assign a label, choose one from the Label submenu. To remove the label, choose “No label” from that menu. When a node has been given a label, that label will be shown in the node menu instead of the word “Label”.

A node cannot have more than one label. Each label is visually indicated in the diagrams using a colour (to disable this, use the setting in the Options panel: see 8.2.2). Note that these colours have no relation with the colours that are associated with vulnerability levels.

The labels themselves are pre-set to the names of their colour, but can be changed by choosing “Edit labels…” from the node menu. Reset a label to its default value by making it blank.

9.3.11 Vulnerability assessment window



Vulnerability assessment for "wired link"

Name	Freq.	Impact	Total	Remark
Kabelbreuk	-	-	-	-
Congestie	-	-	-	-
Ouderdom	-	-	-	-
EMC	-	-	-	-

The vulnerability assessment window is called up using the node menu on diagram nodes (except actors). In the vulnerability assessment window, you can add, remove, and assess vulnerabilities to the node. In this window you can:

- *rename* a vulnerability, by clicking its title (press Enter/click elsewhere to confirm, press Escape to cancel).
- *view* the description of the vulnerability, by hovering the pointer over the title.
- *add* or *edit* remarks.
- *reorder* vulnerabilities, by dragging them into the desired order.
- *change* frequency and impact. Click to activate the selection widget. Click the widget to open it, or type the letter of your choice.
- *remove* a vulnerability, by clicking the minus-button on the right. See the warning in 4.3.1 about removing vulnerabilities.
- *add* a new vulnerability, by clicking the “+ Add vulnerability” button.
- *copy* all vulnerabilities onto a clipboard, using the Copy button.
- *paste* a previously copied set of vulnerability assessments, using the Paste button.

It is not yet possible to add/edit descriptions for vulnerabilities, other than using the checklists.

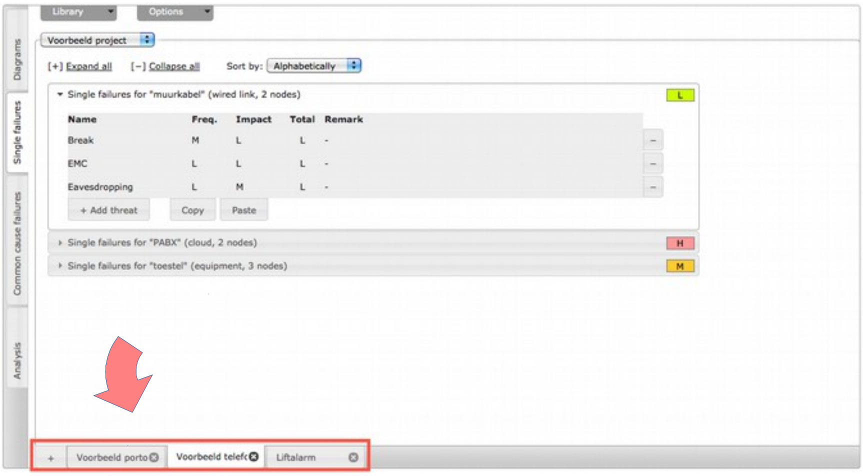
> Copy and Paste also functions between projects. You can copy the checklists or vulnerability assessment in one project, switch to another project, and paste into it.

10 Single failures view

Assess single failures to components.

In the “Single failures” view you can assess all vulnerabilities that affect a single node. This offers similar functionality as the vulnerability assessment window in the diagram workspace, but shows the assessment of more than one node.

10.1 Service tabs



Voorbeeld project

[+] Expand all [−] Collapse all Sort by: Alphabetically

▾ Single failures for "muurkabel" (wired link, 2 nodes) L

Name	Freq.	Impact	Total	Remark
Break	M	L	L	-
EMC	L	L	L	-
Eavesdropping	L	M	L	-

+ Add threat Copy Paste

▸ Single failures for "PABX" (cloud, 2 nodes) H

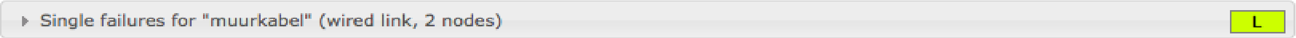
▸ Single failures for "toestel" (equipment, 3 nodes) M

+ Voorbeeld porto Voorbeeld telefc Liftalarm

Like Diagrams view, Single failures view is divided into to tabs, one for each service. You can:

- *view* the vulnerability assessments for all nodes of a service, by clicking its tab.
- *view* the full name of the service (it will be cut off beyond the close button), by hovering the mouse pointer (keeping it stationary) over the truncated name.
- *remove* a service, by clicking the close button on its tab. Note that you cannot remove the last service of a project. If you try to, the workspace will flash briefly.
- *add* a new service to the active project, by using the plus-button.
- *rename* a service, by *double-clicking* its name. A popup window will appear, in which you can enter the new name. End by pressing the Enter key, or click the “Change name” button. Cancel by clicking the Cancel button, or press Escape.
- *re-order* the services, by dragging the tabs into the desired order.

10.2 Vulnerability assessment headers



▸ Single failures for "muurkabel" (wired link, 2 nodes) L

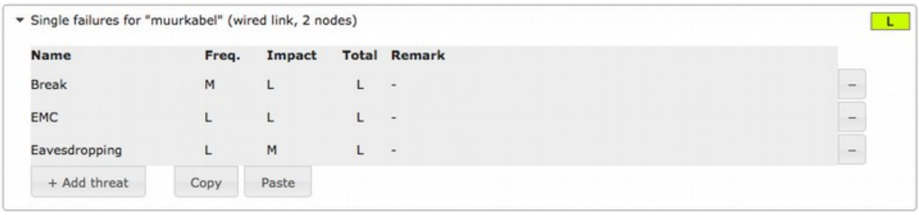
Each node or node class in the selected service is shown using a collapsible header.

With the header you can:

- *see* the vulnerability, the name of the node, its type, and in the case of a node class the number of nodes in that class.
- *see* if the vulnerability assessment is incomplete. The marker *(Incomplete)* appears when any one vulnerability assessment for that node or node class has not been completed. An assessment is complete when both the frequency and impact are set to a value other than “–”.
- *see* the overall vulnerability level, in the coloured emblem on the right side of the header. Hover the mouse pointer over the colour marker to see a short description.

- *open* the vulnerability assessment, by clicking the header of a collapsed vulnerability assessment.
- *close* the vulnerability assessment, by clicking the header of an expanded vulnerability assessment.
- *collapse* or *expand* all vulnerability assessments at once, using the Collapse all and Expand all links at the top of the view.

10.3 Vulnerability assessments



▾ Single failures for "muurkabel" (wired link, 2 nodes)

Name	Freq.	Impact	Total	Remark
Break	M	L	L	-
EMC	L	L	L	-
Eavesdropping	L	M	L	-

When a header is expanded (opened), the full vulnerability assessment of that node becomes visible. In this area you can:

- *rename* a vulnerability, by clicking its title (press Enter/click elsewhere to confirm, press Escape to cancel).
- *view* the description of the vulnerability, by hovering the pointer over the title.
- *add* or *edit* remarks.
- *change* frequency and impact. Click to activate the selection widget. Click the widget to open it, or type the letter of your choice.
- *remove* a vulnerability, by clicking the minus-button on the right. See the warning in 4.3.1 about removing vulnerabilities.
- *add* a new vulnerability, by clicking the “+ Add vulnerability” button.
- *reorder* vulnerabilities, by dragging them into the desired order.
- *copy* all vulnerabilities onto a clipboard, using the Copy button.
- *paste* a previously copied set of vulnerability assessments, using the Paste button.

Be careful when pasting vulnerability assessments; these three rules are used:

1. Vulnerabilities that were present (based on their name) in the source as well as the destination will be combined.
2. On combination, if the probability or impact has been set in both the source and destination, the worst value will be used.
3. Any vulnerabilities listed in the source but not yet present in the destination will be created.

11 Common cause failures view

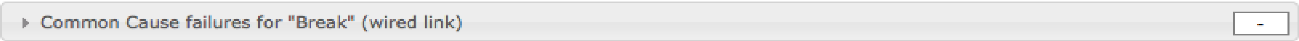
Cluster components and assess common cause failures.

In the common cause failures view, you assess the possibility of two or mode nodes failing simultaneously. Most often, two nodes must be sufficiently close together before a single event can make both fail. For example, two equipment items in the same building will fail in a single area-wide power failure.

The common cause failure view does not have tabs for each service. Common cause failures are assessed for the project as a whole. This assessment is done once for each vulnerability, as long as that vulnerability occurs at least twice in the project. Vulnerabilities that occur only for a single node are not shown; for a common cause failure event to happen, at least two nodes must be involved.

Each vulnerability is presented using a header, followed by assessments for each cluster and finally by the nested list of clusters and nodes.

11.1 Common cause assessment header



Common Cause failures for "Break" (wired link)

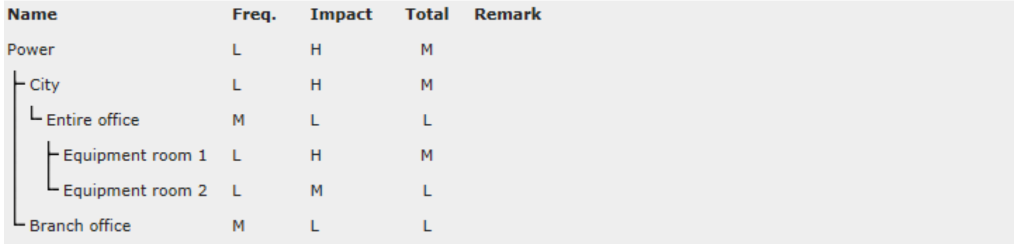
Each common cause vulnerability is shown using a collapsible header. With the header you can:

- *see* the vulnerability, and its type.
- *see* if the vulnerability assessment is incomplete. The marker *(Incomplete)* appears when any one cluster has not been assessed. An assessment is complete when both the frequency and impact are set to a value other than "–".
- *see* the overall vulnerability level, in the coloured emblem on the right side of the header. Hover the mouse pointer over the colour marker to see a short description.
- *open* or *close* the common cause assessment, by clicking the header.

You can collapse or expand all assessments at once, using the Collapse all and Expand all links at the top of the view.

11.2 Vulnerability assessments

When a header is opened (expanded), a table of vulnerability assessments of clusters is show below it. Lines indicate the structure of clusters-within-clusters.



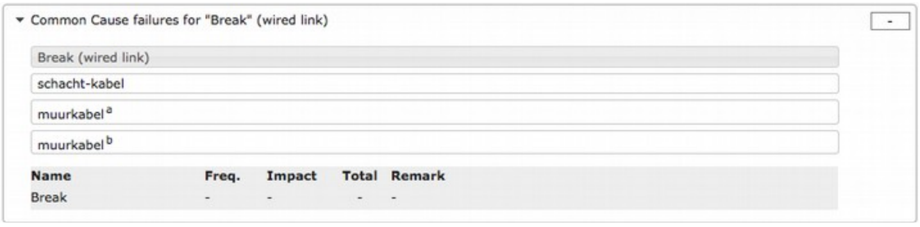
Name	Freq.	Impact	Total	Remark
Power	L	H	M	
├ City	L	H	M	
└ Entire office	M	L	L	
├ Equipment room 1	L	H	M	
└ Equipment room 2	L	M	L	
└ Branch office	M	L	L	

In this area you can:

- *rename* a cluster, by clicking its title (press Enter/click elsewhere to confirm, press Escape to cancel). Note that the root cluster always has the same name as the vulnerability itself, and cannot be renamed.

- *change* frequency and impact. Click to activate the selection widget. Click the widget to open it, or type the letter of your choice.
- *add* or *edit* remarks.

11.3 Nodes and node clusters



▾ Common Cause failures for "Break" (wired link)

Break (wired link)

schacht-kabel

muurkabel [a]

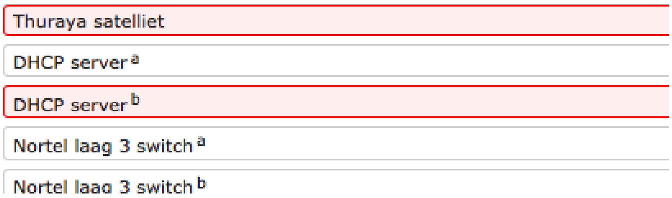
muurkabel [b]

Name	Freq.	Impact	Total	Remark
Break	-	-	-	-

All nodes subject to the vulnerability are listed below the table of vulnerability assessments. Initially all the nodes as shown in a single list, sorted by label and by name. There are two mechanisms to sort nodes into clusters: by using the menus or by 'drag and drop'. Either way you can group nodes into clusters, and rearrange nodes and clusters in a nested structure.

11.3.1 Nodes

Each node is shown using a simple white row. You can select one or more nodes, and use the popup menu to move the selection into a new or existing cluster.



Thuraya satelliet

DHCP server [a]

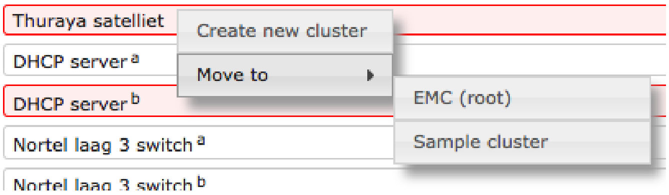
DHCP server [b]

Nortel laag 3 switch [a]

Nortel laag 3 switch [b]

You can:

- *view* the node's service, by hovering the pointer over it.
- *select* a single node, by clicking it. The node is highlighted in red to indicate that it is now selected.
- *unselect* all nodes, by clicking somewhere on the workspace.
- *select* or *unselect* individual nodes, by clicking the node while holding the Control key (on Windows) or the Command key (on Mac OS X).
- *select a series* or nodes, by clicking an unselected node while holding the Shift key. All nodes between the last selected node and the current node become selected.



Thuraya satelliet

DHCP server [a]

DHCP server [b]

Nortel laag 3 switch [a]

Nortel laag 3 switch [b]

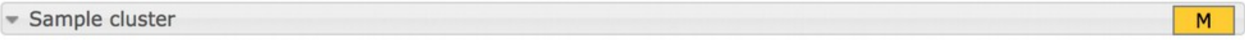
To move all currently selected nodes, use the right mouse button to call up the popup menu.

- *Create new cluster.* Use this menu item to move the selected nodes into a new cluster. The new cluster will become a subcluster in the cluster in which the last nodes was selected.
- *Move to:* Move the selected nodes into an existing cluster.

Note that after moving nodes, any clusters with less than two nodes or subclusters remaining will automatically be cleaned up.

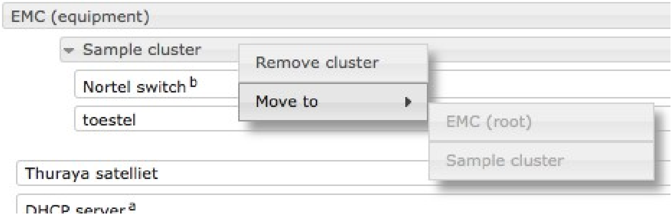
11.3.2 Cluster headers

Each cluster has a header; the nodes in that cluster are listed below the header, after the subclusters (if any). Unlike nodes, cluster headers cannot be selected.



Cluster headers are similar to the common cause assessment header. With the header you can:

- *rename the* cluster, by clicking its title. Note that the area becomes orange when you hover the pointer over the title. Confirm the new title by clicking somewhere outside the workspace, or press Enter. Cancel the action (that is, revert to the current title) by pressing Escape. Note that the root cluster cannot be closed nor renamed; it always has the same name as the vulnerability itself.
- *see* the vulnerability level of the cluster, in the coloured emblem on the right side of the header. Hover the mouse pointer over the colour marker to see a short description. The overall vulnerability level is shown in the common cause assessment header, and will be visible even when that header is collapsed.
- *open* or *close* the cluster, by clicking the header (either on the triangle or to the right of the title).



To move or remove a cluster, use the right mouse button to call up the popup menu.

- *Remove cluster.* Use this menu item to dissolve the cluster. All nodes in the cluster will be moved into the parent cluster.
- *Move to:* Make the cluster a subcluster of an existing cluster.

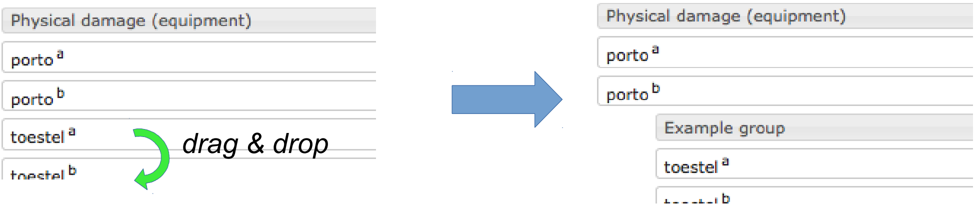
Note that after moving clusters, any clusters with less than two nodes or subclusters remaining will automatically be cleaned up.

11.3.3 Drag and drop

Nodes and clusters can also be arranged and rearranged using 'drag and drop'. Clusters are dragged by dragging their header row. While dragging a node or cluster, all possible drop targets light up in pale green. You can first select a number of nodes, then drag them collectively.

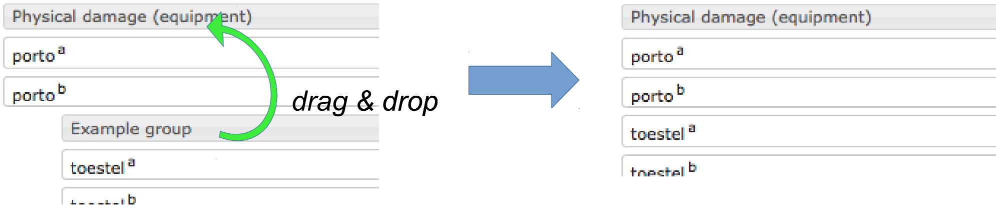
You can:

- *create* a new subcluster, by dragging a node onto another node. Both nodes must belong to the same cluster, and will be combined into a new subcluster thereof. See the picture below. The new cluster will get a default name, and the two member nodes will be shown beneath it, indented from the left margin.

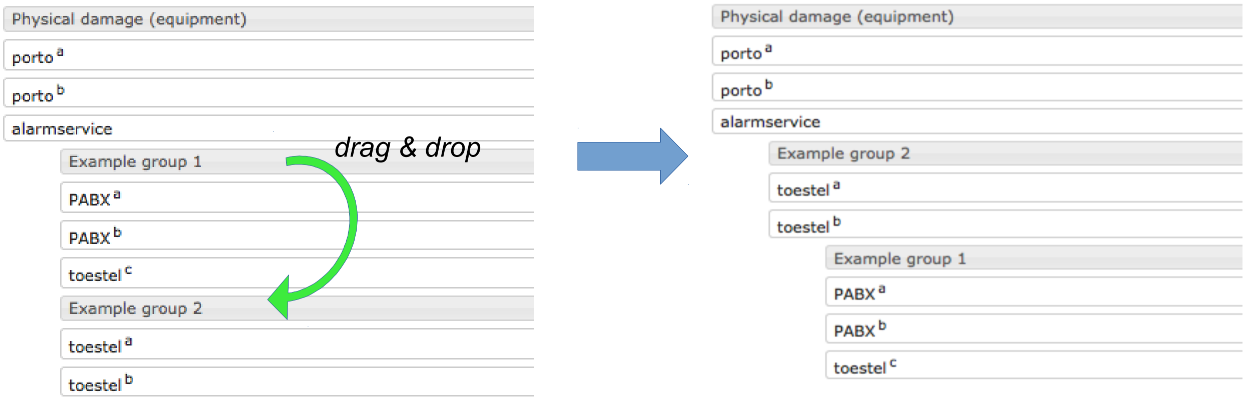


If a number of nodes were selected, all will be moved into the new cluster.

- *move* a node or selection, by dragging it onto the header of any cluster.
- *remove* up a cluster (dissolve it), by dragging the cluster header onto the header of its parent, as illustrated below. The nodes in the cluster will be merged with the parent cluster. When a group is removed, the assessment for that group will be lost.



- *move* a cluster, by dragging its header onto the header of any cluster except its direct parent. The cluster will become a subcluster of the cluster on which it was dropped, as illustrated:



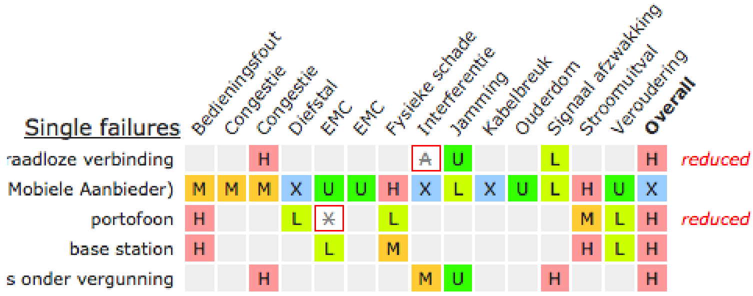
12 Analysis view

View reports and assist in risk evaluation of the project.

The analysis view contains a number of reports, some of them interactive, that are useful in preparing the longlist and shortlist during the Risk Evaluation stage. Tabs along the bottom give access to various tools and reports.

12.1 Failures and vulnerabilities

This table shows a condensed overview of all vulnerabilities against the single failures and common cause failures. It allows you to quickly visualise the most critical nodes.



Single failures	Bedieningsfout	Congestie	Congestie	Diefstal	EMC	EMC	Fysieke schade	Interferentie	Jamming	Kabelbreuk	Ouderdom	Signaal afzwakking	Stroomuitval	Veroudering	**Overall**	
raadloze verbinding			H					~~A~~	U			L			H	*reduced*
Mobiele Aanbieder)	M	M	M	X	U	U	H	X	L	X	U	L	H	U	X	
portofoon	H			L	~~X~~		L						M	L	H	*reduced*
base station	H				L		M						H	L	H	
s onder vergunning			H					M	U			H			H	

This table is interactive. You can:

- *ignore* a vulnerability, by clicking it. The square will colour white with a red border to indicate its status. If ignoring this vulnerability would cause the overall vulnerability level to change, the marked *reduced* appears on the right hand side of the row.
- *include* an ignored vulnerability, by clicking it.
- *include* all ignored vulnerabilities, using the “clear exclusions” button.
- *show* all quick wins automatically, by clicking the “show Quick Wins” button.

Quick wins are those vulnerabilities that by themselves determine the overall vulnerability level. Reducing that vulnerability would immediately reduce the overall level. Quick wins are therefore a useful priority for risk treatment.

12.2 Single failures by level

These tables show an overview of all single failures. The Frequencies table shows how often each frequency was assigned in the Single Failure analysis stage, including the totals per frequency class and per node class. The Impacts table does the same for impact assignments. The last table shows the combined vulnerability levels. All tables are informational.

12.3 Node counts

This table shows the number of occurrence for each node type, for each service and for the project as a whole. It is purely informational.

12.4 Checklist reports

Two overviews help determine how useful the checklists were, and what vulnerabilities were added during the Single Failures stage.

Removed vulnerabilities: lists all vulnerabilities that are present in the checklist for a component, but not on the component itself. Section 4.3.1 warned that vulnerabilities should only be removed when physically impossible. This report helps to verify this.

Custom vulnerabilities: lists all vulnerabilities that are present for a component, but not in its corresponding checklists. This is purely informational.

12.5 Longlist

This longlist view selects all single and common cause vulnerabilities above a chosen level. This can serve as a good first attempt at the longlist in Stage 4 (see section 6.1). Often, the list of all High vulnerabilities together with all Unknown and Ambiguous vulnerabilities can be used as the longlist.

13 Technical issues

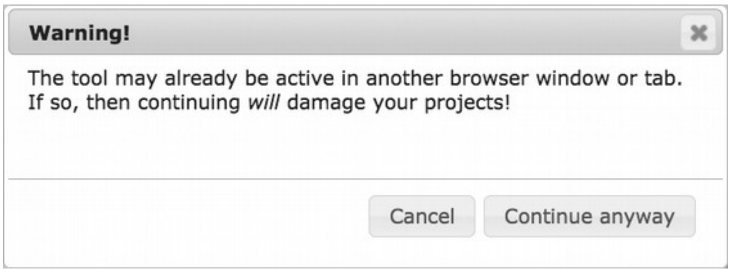
Some technical below-the-surface info.

13.1 The intranet tool

The intranet tool was developed for recent versions of Firefox, Google Chrome, and Safari. The tool probably works on Internet Explorer 11 and later, but this has not been tested extensively.

The interface will use the preferred language setting of your web browser. Currently, only Dutch and English (the default) are available. Configure the language preferences in your web browser to choose the interface language.

It is not possible to use Raster in multiple tabs or windows of the same browser. When Raster is active in more than one browser window or tab, your project data will get damaged and you will likely lose all your work. The tool will warn you when it may already be running in another tab.



Warning!

The tool may already be active in another browser window or tab. If so, then continuing *will* damage your projects!

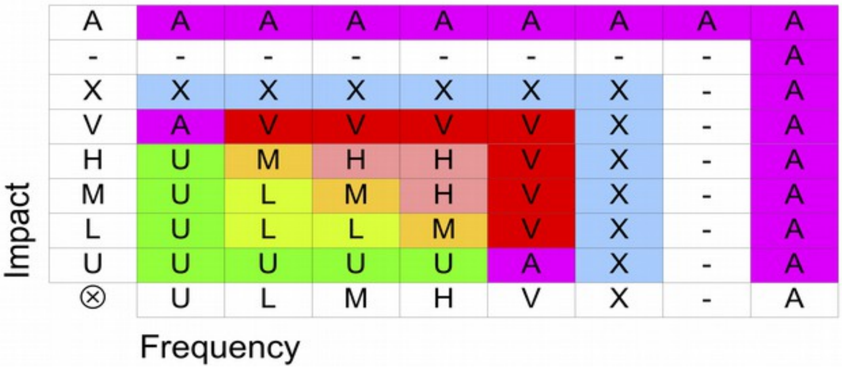
In rare cases you may see this warning even though no other instance of the Raster tool is active. This may happen, for example, when the browser crashed and could not exit cleanly. When this happens, make absolutely clear that Raster is not running elsewhere before continuing.

It is, however, possible to use Raster with two separate browsers on the same computer. For example, once in Firefox and once in Chrome. If the project is not private but shared (see section 8.2), then it is possible to work on the same project simultaneously. Shared projects can also be viewed and edited from two computers simultaneously.

13.2 Computation of vulnerability levels

The following table describes the way that the Raster tool computes a vulnerability level from a frequency and impact class.

As can be seen from the table, the inner part for frequency and impact L, M, and H match expected damage, even though frequency and impact are not fully numerical. These three classes represent modest values, for which 'frequency times impact' assessment is suitable.



Impact								
A	A	A	A	A	A	A	A	A
-	-	-	-	-	-	-	-	A
X	X	X	X	X	X	X	-	A
V	A	V	V	V	V	X	-	A
H	U	M	H	H	V	X	-	A
M	U	L	M	H	V	X	-	A
L	U	L	L	M	V	X	-	A
U	U	U	U	U	A	X	-	A
⊗	U	L	M	H	V	X	-	A

Frequency

When impact is extremely high (V), it does not matter what the frequency is, as the risk is unacceptable at any probability. When frequency is extremely high (i.e. near certainty), we are almost certain that damage will arise, and are therefore obliged to prepare countermeasures. In this case the risk will also be unacceptable.

When the impact is extremely low (i.e. nearly absent, symbol U), we do not really care whether the incident happens; the risk will always be extremely low to us. The same consideration applies for situations where the frequency is extremely low.

These considerations are ambiguous when one of frequency or impact is V, and the other U. However, we do have a class for ambiguity, namely A.

When either the frequency or the impact is not known, the combination also cannot be known. In these combinations, we always want to preserve ambiguity, as we believe that information to be highly relevant to decision makers. When an undetermined value (the minus symbol in the table) is involved, the result must also be undetermined as that value could turn out to be ranked as ambiguous rather than simply unknown; until we assess the value of that factor, the result of the combination is still undetermined. When neither the value A nor – is appropriate, the combination is ranked as a `plain' unknown (symbol X).

The overall vulnerability score for a node is computed by taking the 'maximum' vulnerability score of all vulnerabilities on that node. The vulnerability levels, in order from lowest to highest, are:

(lowest)	**–**	**U**	**L**	**M**	**H**	**X**	**A**	**V**	(highest)

Note that here also the symbol – indicates the 'not yet analysed' level.

Index

Quick reference

Frequency

Class	*Value*	*Symbol*
High	Once in 5 years. For 100 identical components, each month 1 or 2 will experience an incident.	H
Medium	Once in 50 years. For 100 identical components, each year 2 will experience an incident.	M
Low	Once in 500 years. For 100 identical components, one incident will occur every five years.	L
Extremely high	Routine event. Very often.	V
Extremely low	Very rare, but not physically impossible.	U
Ambiguous	Indicates lack of consensus between analysts.	A
Unknown	Indicates lack of knowledge or data.	X
Not yet analysed	Default. Indicates that no assessment has been done yet.	–

Impact

Class	*Value*	*Symbol*
High	Partial unavailability, if unrepairable. Total unavailability, if long-term.	H
Medium	Partial unavailability, if repairable (short-term or long-term). Total unavailability, if short-term.	M
Low	Noticeable degradation, repairable (short-term or long-term) or unrepairable.	L
Extremely high	Very long-term or unrepairable unavailability of the service.	V
Extremely low	Unnoticeable effects, or no actors affected.	U
Ambiguous	Indicates lack of consensus between analysts.	A
Unknown	Indicates lack of knowledge or data.	X
Not yet analysed	Default. Indicates that no assessment has been done yet.	–

Vulnerability levels

-	Not yet analysed, no assessment has been done yet (white)
A	Ambiguous, the assessors have conflicting opinions (purple)
V	Extremely (very) high, an extreme risk (bright red)
H	High (red)
M	Medium (yellow-orange)
L	Low (green-orange)
X	Unknown, because of lack of knowledge (sky blue).
U	Extremely (ultra) low, the risk level is negligible or absent (bright green)

Overview of the Raster method

Stage 1 — Initiation and preparation chapter 3, page 11

1. Identify telecom services
2. Identify actors
3. Describe disaster scenarios
4. Create Stage 1 report
5. Obtain approval from sponsor

Stage 2 — Single failures analysis chapter 4, page 15

1. Update the checklists of vulnerabilities
2. Draw initial diagrams
3. Analyse the frequency and impact of components
4. Expand unknown links
5. Review

Stage 3 — Common cause failures analysis chapter 5, page 23

1. Create clusters
2. Analyse each cluster
3. Expand unknown links
4. Review

Stage 4 — Risk evaluation chapter 6, page 27

1. Determine longlist
2. Reduce longlist to shortlist
3. Draft treatment recommendations
4. Assess social risk factors
5. Prepare final report

Suggested outline of the final report

1. Executive summary to the final report.
2. About the case organisation (internal scope):
   a) Position within wider system of stakeholders.
   b) Tasks.
   c) Responsibilities.
   d) Telecom services used, together with their role and purpose.
   e) Main actors.
3. About the environment of the case organisation (external scope):
   a) Disaster scenarios.
   b) External parties with whom the main actors may communicate.
4. Roles and stakeholders
5. Telecom services
   a) Diagram with explanation (once for each service)
   b) Important risks (single failures and common cause failures)
6. Risk shortlist, with for each risk:
   a) Description
   b) Relevant social risk factors
   c) Justification for risk priority
   d) Recommended risk treatment
7. Conclusions and recommended actions

Appendices:

8. Glossary
9. Reports of single failures
10. Reports of common cause failures