Fault Tree Analysis of cell phone Sony CMD J6

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Sony CMD J6

J6 was introduced in July 2001 as a successor of a model J5. Compared to this model it introduced only minor changes mainly in design, the inside parts remained the same. In these days it was one of the best phones in it's category, competing only with famous Nokia 3310. It provided many advanced features, such as large display with four shades of grey, polyphonic ringtones, possibility of recording own ringtones. It was one of the first mass-produced phones with integrated HTML browser. It had also several drawbacks, it supported only CSD data, which fairly limited the use of the Internet, it does not support EMS. Due to high interest of fans, there were introduced two modified firmwares, which allowed to execute external programs, which greatly enhanced the capabilities of this phone.

Specifications:

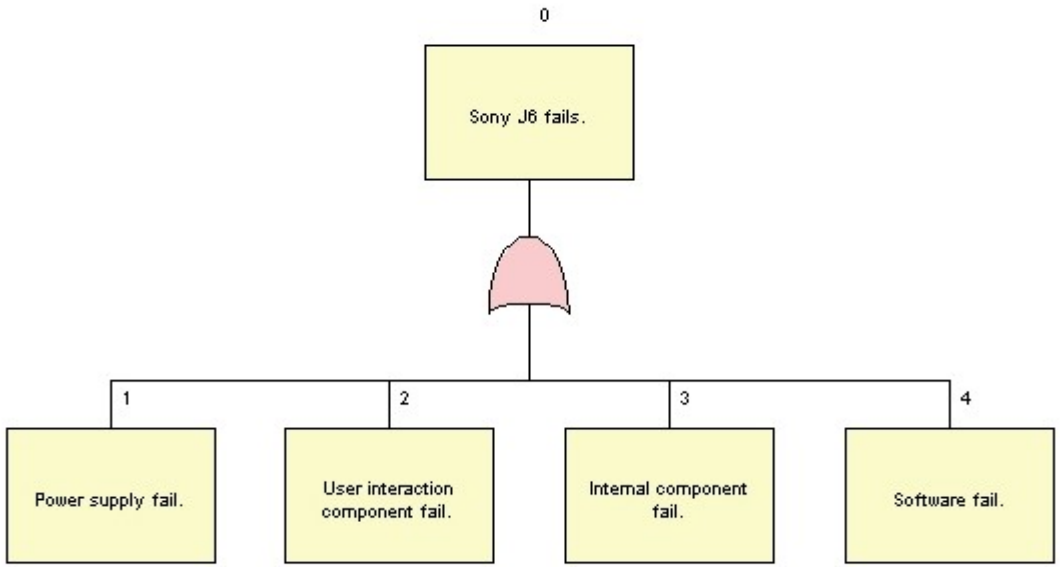
Frequency	dual-band 900/1800 MHz
Dimensions	123 x 42 x 15 mm
Weight	82 g
Power	3,7 V
Battery	Li-Ion 640 mAh, 920 mAh (extended)
User data memory (NVM)	0,5 MB
Display	96 x 92 px, backlighted passive LCD, 4 shades of grey

FTA

FTA is a top-down failure analysis used for discovering the root causes of failures or potential failures. It uses boolean logic to combine a series of lower-level events. The more extensive description is presented in my previous work FMEA and FTA.

Causes and means of failure

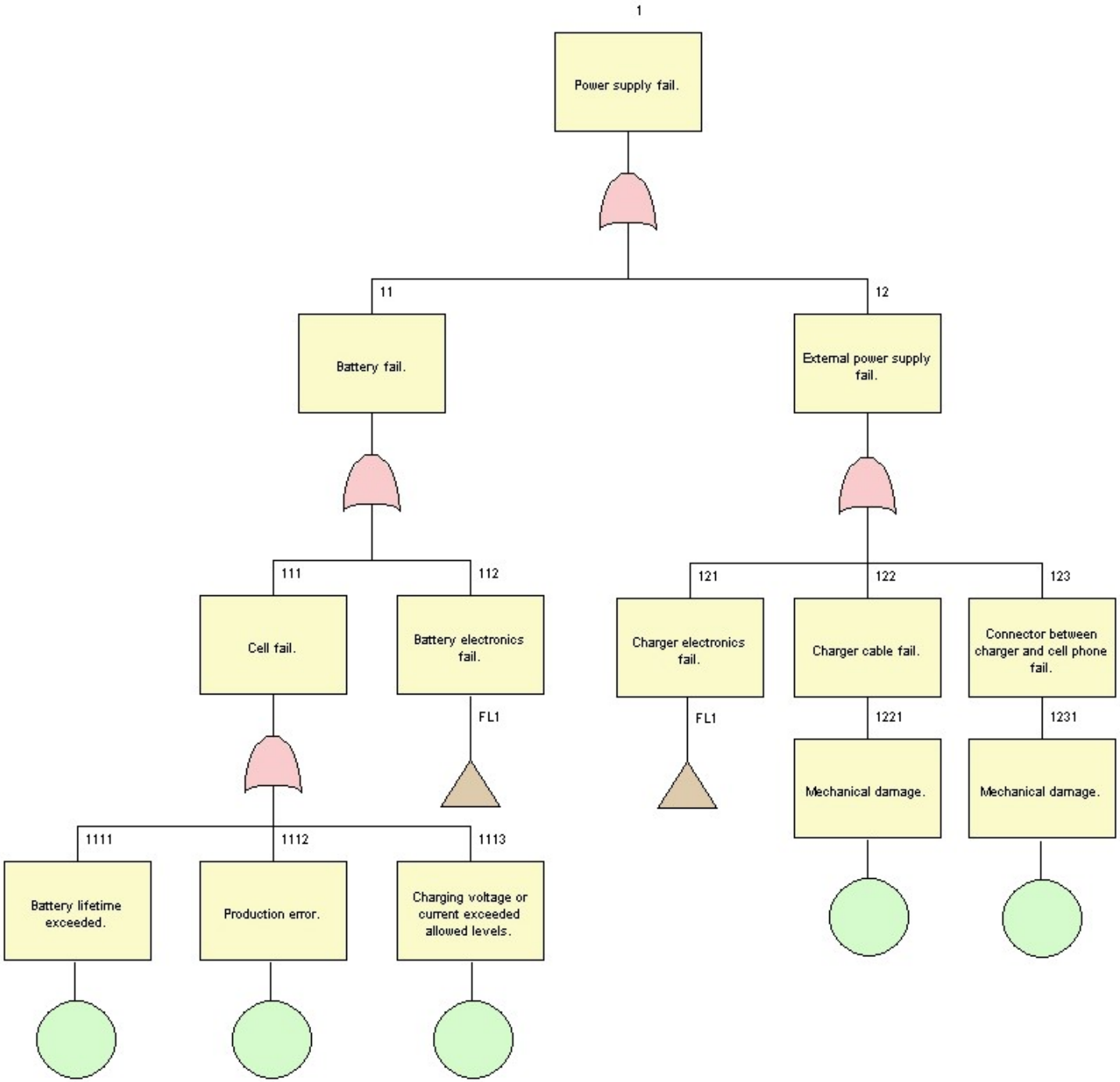
The root action is failure of the device, the cause of what may be in several nodes.



Each of the nods may cause the device to fail or at least not to operate properly.
As the following step, we will look more deeply into each of the parts.

1. Power supply fail

The device is powered by replaceable Lithium Ion battery with capacity of 640 mAh. Battery is charged using pulse power source with input 100-240 V, 50-60 Hz, 300 mA, and output 5 V DC, 500 mA. The fault tree diagram(FTD) can be seen on next page.


1
Power supply fail.
11
Battery fail.
12
External power supply fail.
111
Cell fail.
112
Battery electronics fail.
121
Charger electronics fail.
122
Charger cable fail.
123
Connector between charger and cell phone fail.
FL1
FL1
1221
Mechanical damage.
1231
Mechanical damage.
1111
Battery lifetime exceeded.
1112
Production error.
1113
Charging voltage or current exceeded allowed levels.

1.1 Battery fail

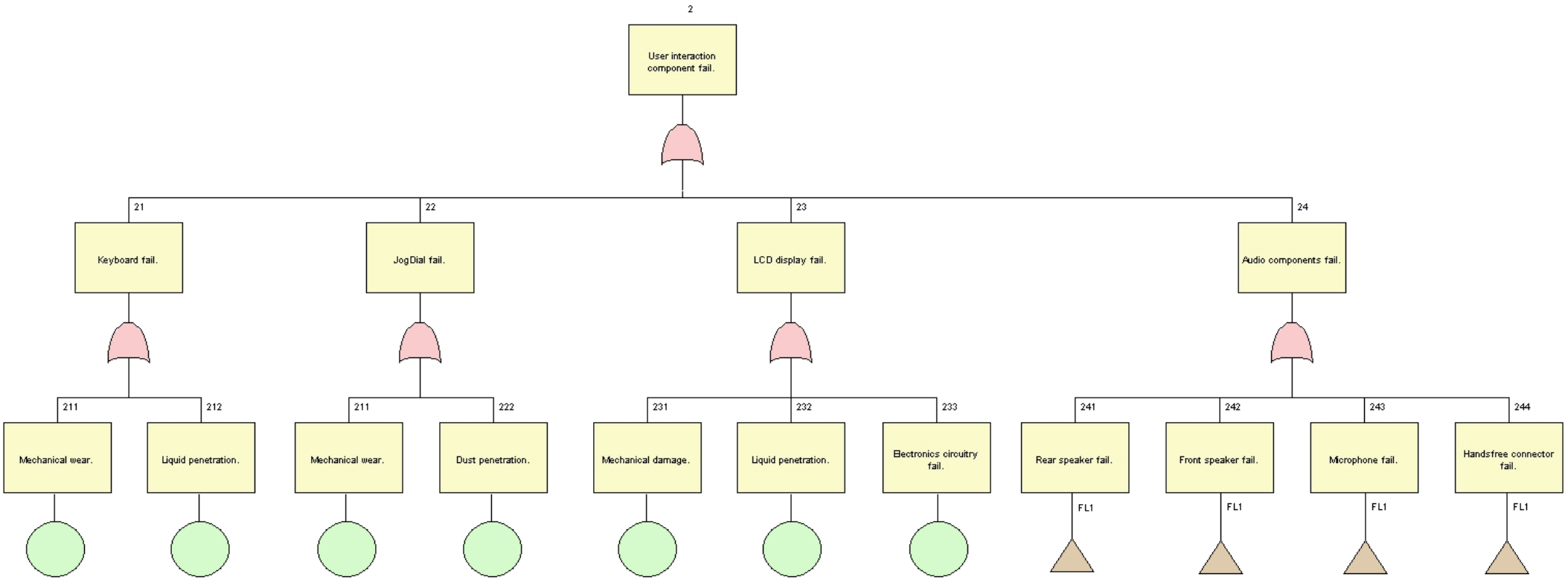
The battery consists of battery cell and electronics, which serves as a real-time clock and for battery state diagnosis during the charging. The cell may fail due to physical damage caused by overcharge, or due to inability to load part of the firmware, which handles the charging when the battery is discharged on very low level. When the battery electronics fail, battery may get overheated or the phone is no more provided with the real-time clock data.

1.2 External power supply fail

The charger is due to its construction quite sturdy, however the electronics is sensible to the overvoltage. The connector contains two pins and a small plastic attachment part. Both of them may be easily bent or broken by incorrect manipulation. Connector on the phone may experience oxidation of the metal parts.

2. User interaction components fail

The phone is operated by using Sony's JogDial, which is a wheel placed up on the left side of the device. Underneath is a side switch for locking the keyboard and setting the ring mode. On the front side, there is a standard 12 key numeric keyboard; Send key; On/Off, Call end and Clear key; and the Centre key. Above the keys there is a monochromatic display. On the top and bottom part of the front side, speaker and microphone are placed. Rear speaker is placed on the back side of the device and is used for ringing or as a built-in handsfree. The connector for standard handsfree is placed above Jog Dial. FTD of this part is on next page.



2.2 Jog Dial fail

Jog Dial is the most used control part of the device and due to its construction it suffers the most. Since the major part is placed inside the phone, the dust intrudes into the internal part and clog the rotation detection part. Repetitive clicking also affects the spring mechanism.

2.4.1 Rear speaker fail

This in one of the more common fails, however the actual reason is fairly unclear.

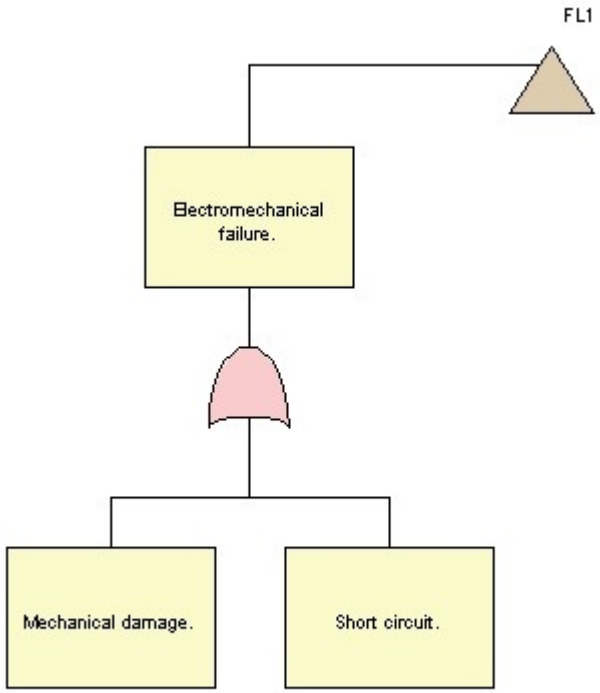
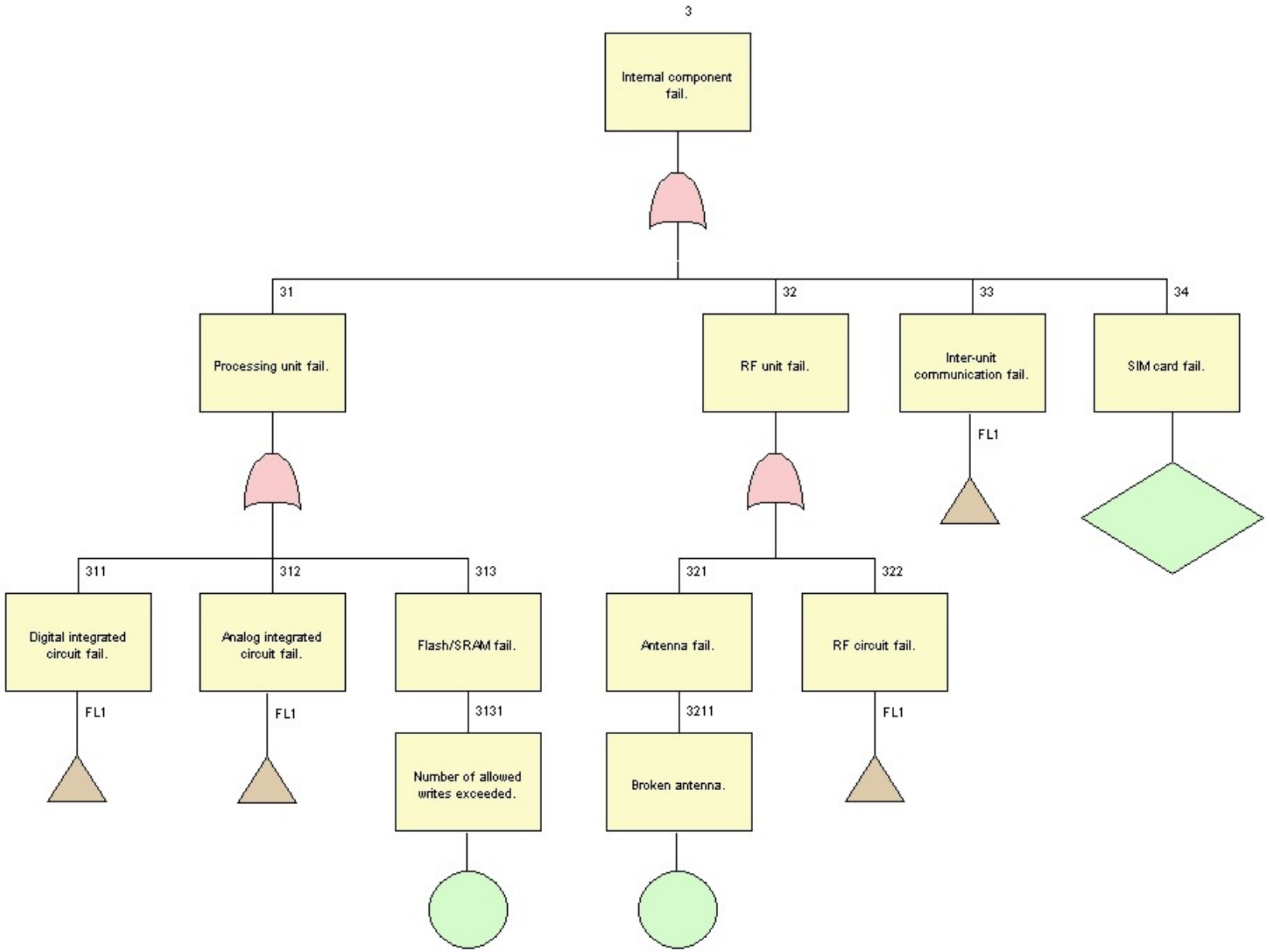


Diagram of Electromechanical failure

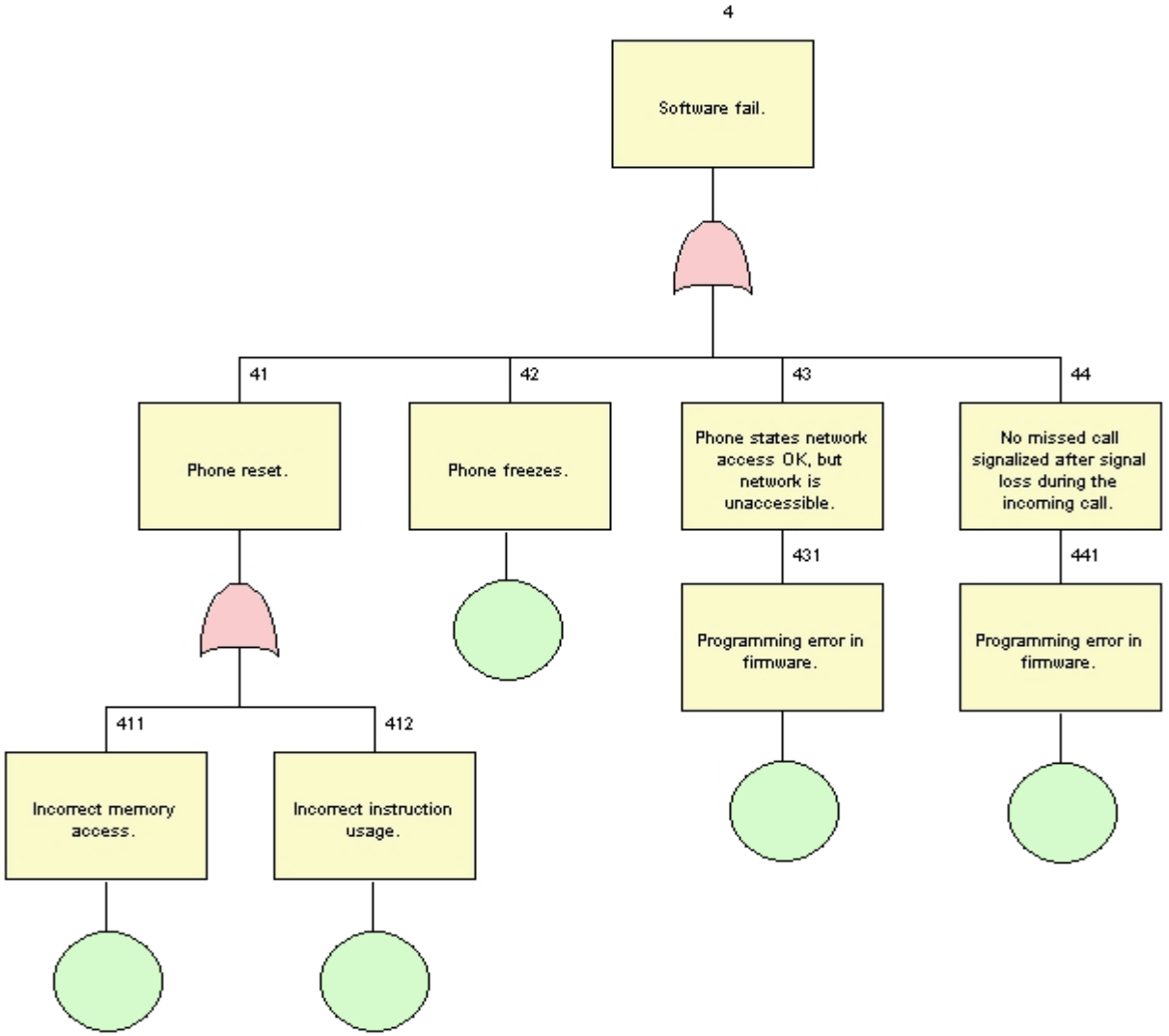
3. Internal component fail

Inside parts of the phone are situated mainly on the mainboard and vast part of them is covered by metal coverage, protecting them against electromagnetic radiation. The circuitry is not very well described, however the main threat is short circuit or mechanical damage.


3
Internal component fail.
31
Processing unit fail.
32
RF unit fail.
33
Inter-unit communication fail.
34
SIM card fail.
FL1
311
Digital integrated circuit fail.
312
Analog integrated circuit fail.
313
Flash/SRAM fail.
321
Antenna fail.
322
RF circuit fail.
FL1
FL1
3131
Number of allowed writes exceeded.
3211
Broken antenna.
FL1

4. Software fail

The software may also induce a faulty state. One of the most common problems is invalid access to the memory, which usually ends in phone reset. The software has also many minor bugs, which however does not affect the main functions of the cell phone..



Conclusion

It has shown, that the cell phone contains almost no redundancies, since no AND gate was used. Unfortunately we don't have data for more detailed analysis and incorporation of failure probabilities.