TECHNISCHE UNIVERSITÄT CHEMNITZ

Professur Betriebssysteme

7. Excercise

Dependable Systems

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Problem 1

Theoretical Questions:

a) What purpose does the fault diagnosis serve?

b) What is the difference between diagnosis and verification/validation/testing/model checking?

c) What kind of checks do you know of? Give corresponding examples.

d) To prove non-orthogonality of the defined categories, give an example where the method can be classified into several groups.

e) What are the design criteria for memory diagnostics?

f) Explain the functioning principle of Hamming Code. Define Hamming distance.

g) Define t-diagnosibility of a system.

h) Define PMC Model and describe the conditions, when a system is t-diagnosable under the PMC model (in general case).

i) Define BGM Model and describe the conditions, when a system is t-diagnosable under the BGM model (in general case).

Problem 2

A simple method for error correction on the receiver side is the repetitive sending of data bits. Altogether, each data bit will be sent n times. Such a code is called *a repetition code*.

a) What value should be chosen for n so that it is possible to correct all 1-bit errors (not only to detect them)?

b) Assume that $n = 11$. Which types of errors are detectable and which ones can be corrected in this way?

c) What is the redundancy in the previous two cases?

Source: Dirk Müller - Dependable Systems, TU Chemnitz 2013

Problem 3

The (7;4;3)-Hamming code was invented in 1950.

a) Give a valid pair of the generator matrix G and the parity-check matrix P.

b) Show that matrix multiplicaiton of the parity-check matrix H with an arbitrary code word c always gives the syndrome $= 0$. How many cases have to be distinguished? (Hint: Hamming code is linear).

c) Let the received data be disturbed by a 1-bit error according to $r = c + e$. What are the consequences for the syndrome? How can the position of the flipped bit be deduced?

d) Let the received data be disturbed by a 2-bit error according to $r = c + e$. The procedure from c) gives again a hint where an erroneous bit should be. But it doesn't work. Even with the correct assumption of a 2-bit error, there are several possibilities. Verify and interpret it.

e) A solution for detecting all 2-bit errors is the application of the (8;4)-code. Design such a code by extending the parity-check matrix H. Check and explain its functionality.

f) The family of Hamming codes has parameters has parameters $(2^m - 1; 2^m - m - 1; 3)$. Is there a Hamming code which is a repetition code at the same time?

Source: Dirk Müller - Dependable Systems, TU Chemnitz 2013

Problem 4 (optional)

Given the generator polynomial $G(x) = x^4 + x + 1$ of a CRC code and the data to be transmitted 1101011011.

a) Determine check bits to be attached for transmission

b) Show that, assumed undisturbed transmission, a check at the receiver really results in remainder 0

c) Inject a 1-bit error into the data bits and compute the remainder

d) Is there an error locator polynomial (bit pattern) that falsely leads to remainder 0?

e) Is it possible that check division at the receiver results it a remainder different from 0 although data has been transmitted correctly?

f) Why is the approach still so common in practice?

g) The coding via parity can be embedded into CRC codes. What is the correpsonding generator polynomial?

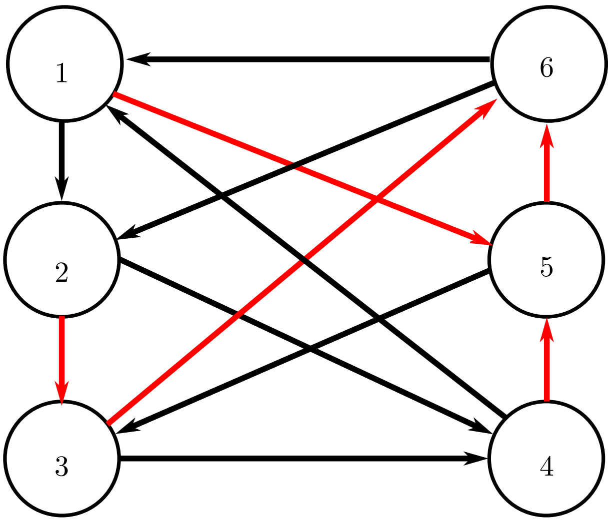
Source: Dirk Müller - Dependable Systems, TU Chemnitz 2013

Problem 5

A Berger Code adds a number of check bits to the data word. Those are computed by counting all the zeroes in the information word, and expresses that sum as a binary. What is the coverage of a 10 bit Berger Code (7/3) for double bit faults?

Problem 6

Given the syndrome (s. figure), find a correct node by means of the modified Sullivan algorithm.



References

[1] Geffroy, J., Motet, G. - Design of dependable computing systems. 2002 Kluwer Academic Publ.

[2] Andrew S. Tanenbaum, David J. Wetherall - Computer Networks