

Exercise 2

1 Relations Among Failure Detectors

A perfect failure detector abstraction is specified in Module 2.6 [CGR11, p. 50]. Consider a *non-perfect* failure detector notion with the same interface as in Module 2.6, which only satisfies the following completeness notion:

NPFD: *Weak completeness:* Eventually every process that crashes is permanently detected by *some* correct process.

But it still satisfies the *strong accuracy* property.

Implement a perfect failure detector abstraction from this non-perfect variant. (You should describe an emulation that satisfies all properties of the perfect failure detector using the output from the non-perfect one.)

2 Safety and Liveness

On the opposing sides of a canyon, there are two armies, each led by a different general. General *A* and General *B* want to attack a third army (led by General *Y*), which travels through the valley of the canyon. However, the third army is quite strong, and in order to succeed, both generals need to attack at exactly the same time. Thus, both generals devised the following algorithm for a coordinated attack:

- General *A* chooses an attack time t and sends a messenger m_1 carrying t (denoted $m_1(t)$) to General *B*.
- General *B* waits for m_1 . Upon the arrival of $m_1(t)$, General *B* sends a messenger m_2 carrying a confirmation to General *A*. Then it waits for time t and attacks.
- General *A* waits for m_2 . Upon the arrival of m_2 , General *A* waits for time t and attacks.

Which of the following properties are safety properties, which ones are liveness properties, and which ones are a mixture of the two? (See Sect. 2.1.3 [CGR11].) Explain your answers.

- (a) If some general attacks at time t , then the other general attacks at the same time.
- (b) If General *A* attacks at time t , then General *B* attacks at the same time.
- (c) If General *B* never attacks, then General *A* never attacks.
- (d) Eventually, General *B* will attack.
- (e) If messengers m_1 and m_2 are not intercepted, then eventually both generals attack.
- (f) If messengers m_1 and m_2 are not intercepted, then eventually both generals attack at time t .