1 | Miniproject in Distributed Real Time Systems

Arrival Functions

Three models are considered in this section, a staircase, an affine, and a linear model as seen on Figure 1.1. The staircase and affine models are used to approximate the real unknown arrival function, while the linear model is a service curve showing the capabilities of the network.

The staircase arrival model in relation to the real unknown arrival function is given by

$$R(t) \leq Sc(t) = \left\lceil \frac{t - \text{offset}}{T} \right\rceil \times P \quad , \tag{1.1}$$

where

$R(t)$	is the real unknown arrival curve.
$Sc(t)$	is the staircase model arrival curve for the wheel sensor data.
t	is the time.
offset	is the time offset measured from $t = 0$ to first packet arrival.
T	is the period time for packet arrivals.
P	is the packet size.

The worst case is when the offset goes to zero, this means that a packet arrives at time zero.

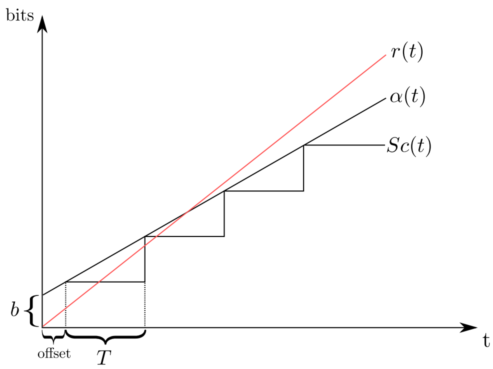

Figure 1.1: $Sc(t)$ is the staircase arrival curve, $\alpha(t)$ is the affine model arrival curve and $r(t)$ is the service curve defined by the capabilities of the CAN Bus.

The affine arrival model in relation to the real unknown arrival function is given by

$$R(t) \leq \alpha(t) = b + \frac{P}{T}t \tag{1.2}$$

where

α is the affine model arrival curve

b is the crossing of the affine curve with the y-axis

The relation between both models and the unknown real arrival function is then given by

$$R \leq Sc \leq \alpha \tag{1.3}$$

Wheel Sensor Data Arrival

The staircase arrival model for the wheel sensor data is

$$Sc_{\mathrm{w}}(t) = \left\lceil \frac{t - \cancelto{0}{\text{offset}}}{T_{\mathrm{w}}} \right\rceil \times P_{\mathrm{w}} \tag{1.4}$$

$$Sc_{\mathrm{w}}(t) = \left\lceil \frac{t}{0.04} \right\rceil \times 160 \quad , \tag{1.5}$$

where $P_{\mathrm{w}} = 20 \times 8$ since the packet size is 20 B, which means that 160 b arrive at each time interval, $T = 0.04$. The time offset is set to zero in order to model for worst case. The affine arrival model for the wheel sensor data is

$$\alpha_{\mathrm{w}}(t) = b + \frac{P_{\mathrm{w}}}{T_{\mathrm{w}}}t \tag{1.6}$$

$$\alpha_{\mathrm{w}}(t) = 160 + \frac{160}{0.04}t = 160 + 6.4t \quad , \tag{1.7}$$

where $b = P_{\mathrm{w}} = 160$ since the time offset is set to zero to model worst case.

Electronic Speed Control (ESC) Data Arrival

The staircase arrival model for the wheel sensor data is

$$Sc_{\mathrm{ESC}}(t) = \left\lceil \frac{t - \cancelto{0}{\text{offset}}}{T_{\mathrm{ESC}}} \right\rceil \times P_{\mathrm{ESC}} \tag{1.8}$$

$$Sc_{\mathrm{ESC}}(t) = \left\lceil \frac{t}{0.4} \right\rceil \times 64 \quad , \tag{1.9}$$

where $P_{\mathrm{ESC}} = 8 \times 8$ since the packet size is 8 B, which means that 64 b arrive at each time interval, $T = 0.4$. The time offset is again set to zero in order to model for worst case. The affine arrival model for the wheel sensor data is

$$\alpha_{\mathrm{ESC}}(t) = b + \frac{P_{\mathrm{ESC}}}{T_{\mathrm{ESC}}}t \tag{1.10}$$

$$\alpha_{\mathrm{ESC}}(t) = 64 + \frac{64}{0.4}t = 64 + 25.6t \quad , \tag{1.11}$$

where $b = P_{\mathrm{ESC}} = 64$ since the time offset is set to zero to model worst case.

Service Model

The curve for the service model, $r(t)$, is seen in Figure 1.1. The model is linear and defined by the capabilities of the CAN Bus with a rate of 1 Mbps.

1.1 Token Filter

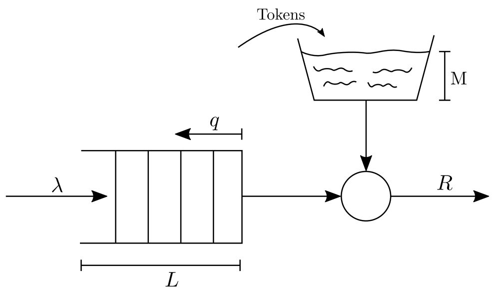

Figure 1.2: Token filter

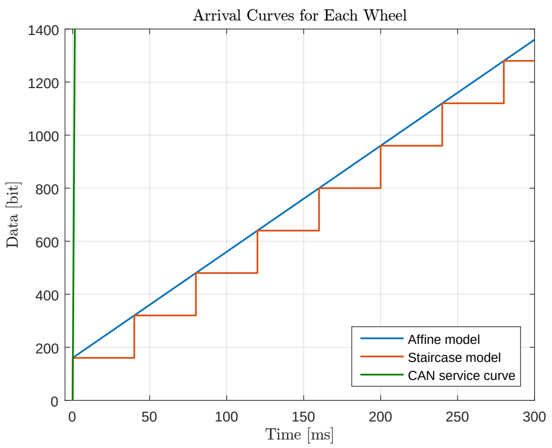

Figure 1.3: Arrival curves for the four wheels and service curve for the CAN-bus.

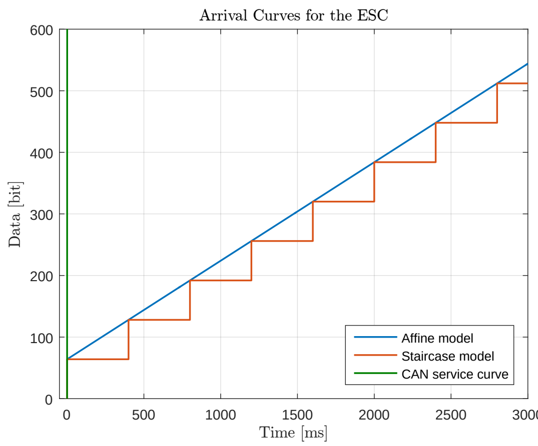

Figure 1.4: Arrival curves for the ESC and service curve for the CAN-bus.

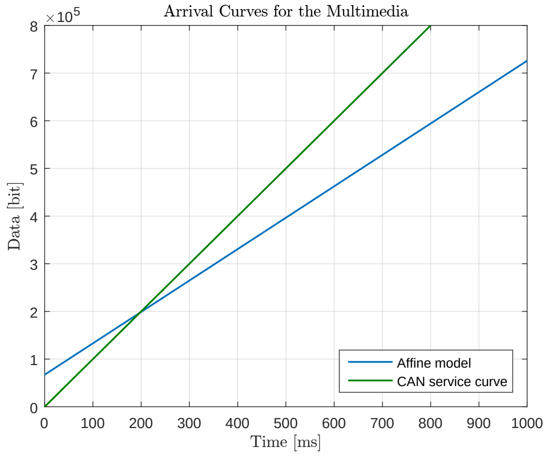

Figure 1.5: Arrival curves for the Multimedia and service curve for the CAN-bus.

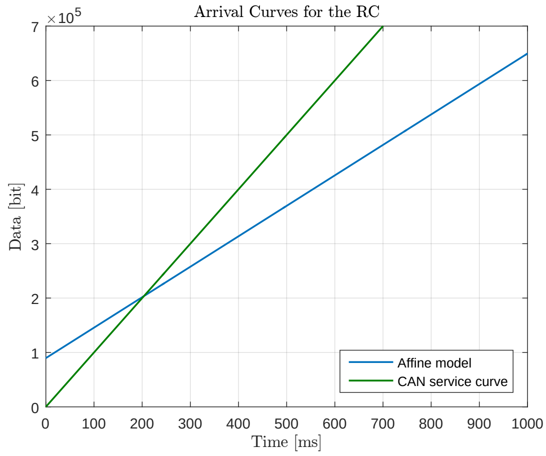

Figure 1.6: Arrival curves for the RC and service curve for the CAN-bus.