PROJECT 1

Device Programming and Cyclic Scheduler

Real time systems

Course 2022/2023

Participants:

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SECTION A

Arduino module

ORIGINAL	T/D (ms)	C (ms)
CS: Communication Server	200	9.368
A: On/Off Accelerator	50	0.016
B: On/Off Break	50	0.016
M: On/Off Mixer	50	0.016
S: Compute and show speed	50	0.128
RS: Read slope	50	0.012

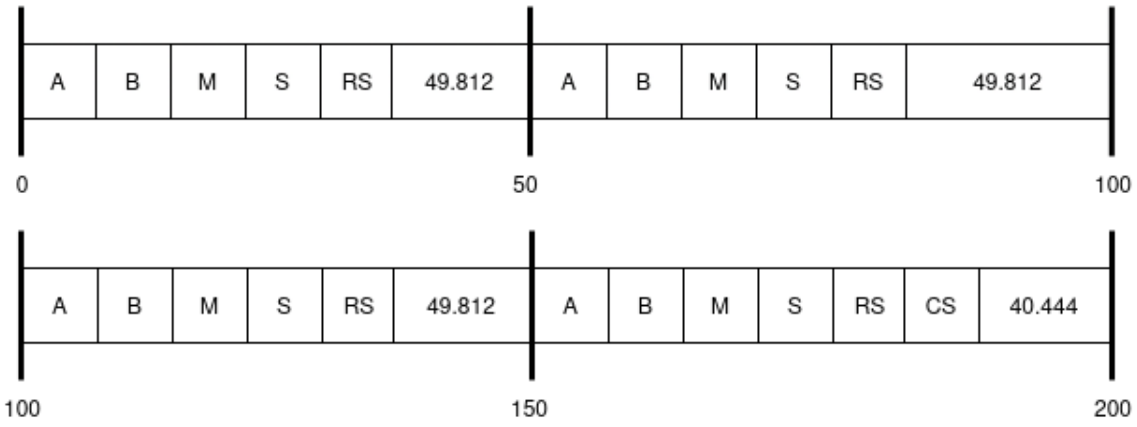
Communication server includes the compute time for the functions that handle requests. T=50 was chosen arbitrarily for most tasks; it is a valid period, smaller than 200 and conveniently makes all periods harmonic.

CPU usage, main and secondary cycles:

$$U = 9.368/200 + 3 * (0.016/50) + 0.128/50 + 0.012/50 = 0.0506 < 1$$

$$MC = mcm(200, 10) = 200 \qquad SC = min(Ti) = 50$$

Cyclic Scheduler:



Software module

We will reduce the periods to make it harmonic:

ORIGINAL	T=D	C
SL: Read Slope	10	0.9
SP: Read Speed	10	0.9
A: Accelerator On/Off	10	0.9
B: Brake On/Off	10	0.9
M: Mixer On/Off	15	0.9

REDUCED	T=D	C
SL: Read Slope	10	0.9
SP: Read Speed	10	0.9
A: Accelerator On/Off	10	0.9
B: Brake On/Off	10	0.9
M: Mixer On/Off	10	0.9

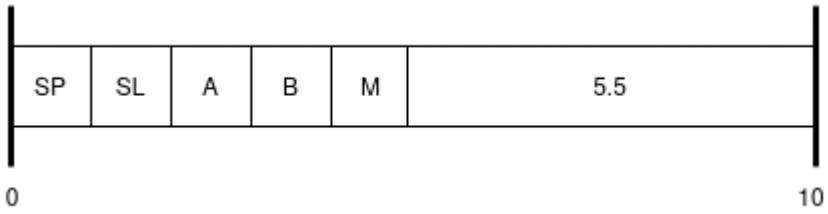
T=10 was chosen arbitrarily for most tasks, and T=15 for the Mixer task, since its state should change every 30 seconds; they are valid periods, and conveniently make all periods harmonic.

CPU usage, main and secondary cycles:

$$U = 5 * (0.9/10) = 0.45 < 1$$

$$MC = mcm(10) = 10 \qquad SC = min(Ti) = 10$$

Cyclic Scheduler:



SECTION B

Arduino module

ORIGINAL	T/D (ms)	C (ms)
CS: Communication Server	200	9.368
A: On/Off Accelerator	100	0.016
B: On/Off Break	100	0.016
M: On/Off Mixer	100	0.016
S: Compute and show speed	100	0.128
RS: Read slope	100	0.012
RL: Read Light Sensor	100	0.212
L: On/Off Lamps	100	0.008

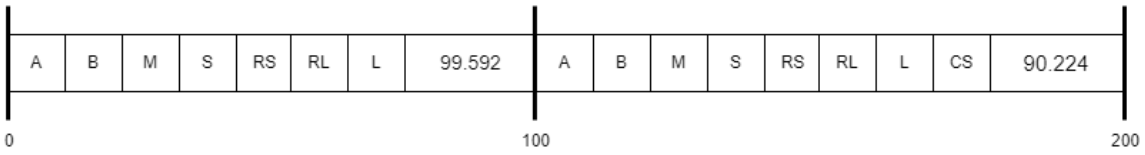
Communication server includes the compute time for the functions that handle requests. T=100 was chosen arbitrarily for most tasks; it is a valid period, smaller than 200 and conveniently makes all periods harmonic.

CPU usage, main and secondary cycles:

$$U = 9.368/200 + (3 * 0.016 + 0.128 + 0.012 + 0.212 + 0.008)/100 = 0.05092 < 1$$

$$MC = mcm(200, 10) = 200 \qquad SC = min(Ti) = 100$$

Cyclic Scheduler:



Software module

We will reduce the periods to make it harmonic:

ORIGINAL	T=D	C
SL: Read Slope	10	0.9
SP: Read Speed	10	0.9
A: Accelerator On/Off	10	0.9
B: Brake On/Off	10	0.9
M: Mixer On/Off	15	0.9
RL: Read Light	6	0.9
L: Lamps On/Off	6	0.9

REDUCED	T=D	C
SL: Read Slope	10	0.9
SP: Read Speed	10	0.9
A: Accelerator On/Off	10	0.9
B: Brake On/Off	10	0.9
M: Mixer On/Off	10	0.9
RL: Read Light	5	0.9
L: Lamps On/Off	5	0.9

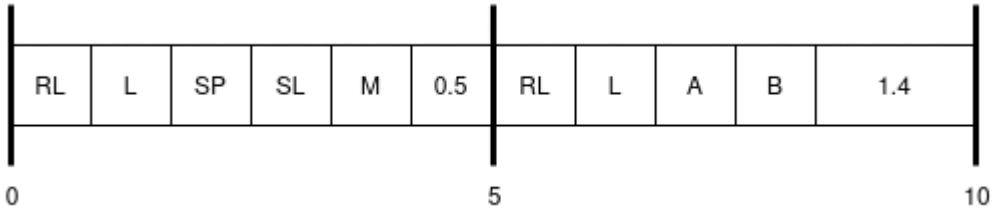
T=6 was chosen arbitrarily for Read Light and Lamps tasks, since the lights should be updated every 12 seconds.

CPU usage, main and secondary cycles:

$$U = 5 * (0.9/10) + 2 * (0.9/5) = 0.81 < 1$$

$$MC = mcm(5, 10) = 10 \qquad SC = min(Ti) = 5$$

Cyclic Scheduler:



SECTION C

Arduino module

DISTANCE SELECTION MODE SCHEDULER

ORIGINAL	T/D (ms)	C (ms)
CS: Communication Server	200	9.368
A: On/Off Accelerator	100	0.016
B: On/Off Break	100	0.016
M: On/Off Mixer	100	0.016
S: Compute and show speed	100	0.128
RS: Read slope	100	0.012
RL: Read Light Sensor	100	0.212
L: On/Off Lamps	100	0.008
DS: Distance selection	100	0.208
DD: Display distance	100	0.128
V: Validate distance	100	0.016

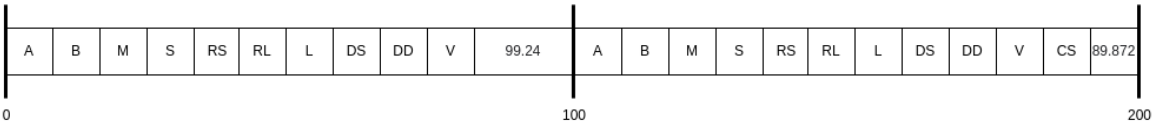
Communication server includes the compute time for the functions that handle requests. T=100 was chosen arbitrarily for most tasks; it is a valid period, smaller than 200 and conveniently makes all periods harmonic.

CPU usage, main and secondary cycles:

$$U = 9.368/200 + (4 * 0.016 + 0.128 + 0.012 + 0.212 + 0.008 + 0.208 + 0.128)/100 = = 0.0544 \ < 1$$

$$MC = mcm(200, 10) = 200 \qquad SC = min(Ti) = 100$$

Cyclic Scheduler:



APPROACH MODE SCHEDULER

ORIGINAL	T/D (ms)	C (ms)
CS: Communication Server	200	9.368
A: On/Off Accelerator	100	0.016
B: On/Off Break	100	0.016
M: On/Off Mixer	100	0.016
S: Compute and show speed	100	0.128
RS: Read slope	100	0.012
RL: Read Light Sensor	100	0.212
L: On/Off Lamps	100	0.008
DD: Display distance	100	0.128

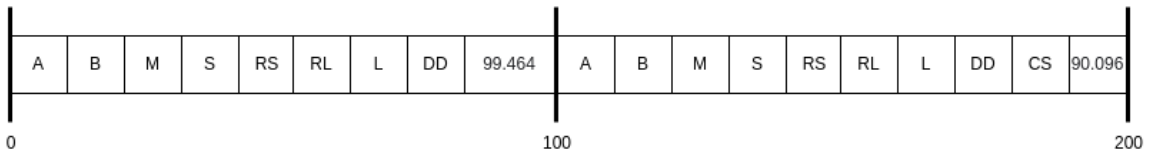
Communication server includes the compute time for the functions that handle requests. T=100 was chosen arbitrarily for most tasks; it is a valid period, smaller than 200 and conveniently makes all periods harmonic.

CPU usage, main and secondary cycles:

$$U = 9.368/200 + (3 * 0.016 + 0.128 + 0.012 + 0.212 + 0.008 + 0.128)/100 = \\ = 0.0522 \ < 1$$

$$MC = mcm(200, 10) = 200 \qquad SC = min(Ti) = 100$$

Cyclic Scheduler:



STOP MODE SCHEDULER

ORIGINAL	T/D (ms)	C (ms)
CS: Communication Server	200	9.368
A: On/Off Accelerator	100	0.016
B: On/Off Break	100	0.016
M: On/Off Mixer	100	0.016
S: Compute and show speed	100	0.128
RS: Read slope	100	0.012
RL: Read Light Sensor	100	0.212
L: On/Off Lamps	100	0.008
RE: Read end of stop	100	0.016

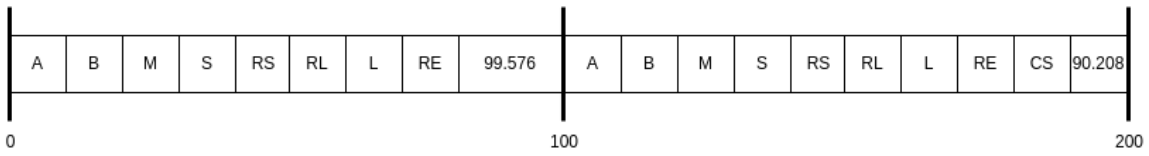
Communication server includes the compute time for the functions that handle requests. T=100 was chosen arbitrarily for most tasks; it is a valid period, smaller than 200 and conveniently makes all periods harmonic.

CPU usage, main and secondary cycles:

$$U = 9.368/200 + (4 * 0.016 + 0.128 + 0.012 + 0.212 + 0.008)/100 =$$
$$= 0.05108 \ < 1$$

$$MC = mcm(200, 10) = 200 \qquad SC = min(Ti) = 100$$

Cyclic Scheduler:



Software module

NORMAL MODE

We will reduce the periods to make it harmonic:

ORIGINAL	T=D	C
SL: Read Slope	10	0.9
SP: Read Speed	10	0.9
D: Read Distance	10	0.9
A: Accelerator On/Off	10	0.9
B: Brake On/Off	10	0.9
M: Mixer On/Off	15	0.9
RL: Read Light	6	0.9
L: Lamps On/Off	6	0.9

REDUCED	T=D	C
SL: Read Slope	10	0.9
SP: Read Speed	10	0.9
D: Read Distance	10	0.9
A: Accelerator On/Off	10	0.9
B: Brake On/Off	10	0.9
M: Mixer On/Off	10	0.9
RL: Read Light	5	0.9
L: Lamps On/Off	5	0.9

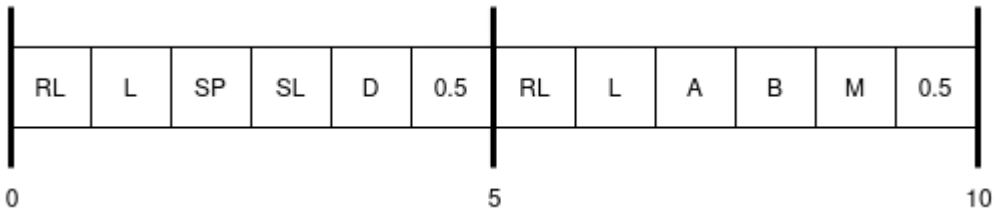
T=10 was chosen arbitrarily for the Read Distance task.

CPU usage, main and secondary cycles:

$$U = 6 * (0.9/10) + 2 * (0.9/5) = 0.9 < 1$$

$$MC = mcm(5, 10) = 10 \qquad SC = min(Ti) = 5$$

Cyclic Scheduler:



BRAKING MODE

We will reduce the periods to make it harmonic:

ORIGINAL	T=D	C
SL: Read Slope	10	0.9
SP: Read Speed	5	0.9
D: Read Distance	10	0.9
A: Accelerator On/Off	5	0.9
B: Brake On/Off	5	0.9
M: Mixer On/Off	15	0.9
L: Lamps On/Off	30	0.9

REDUCED	T=D	C
SL: Read Slope	10	0.9
SP: Read Speed	5	0.9
D: Read Distance	10	0.9
A: Accelerator On/Off	5	0.9
B: Brake On/Off	5	0.9
M: Mixer On/Off	10	0.9
L: Lamps On/Off	30	0.9

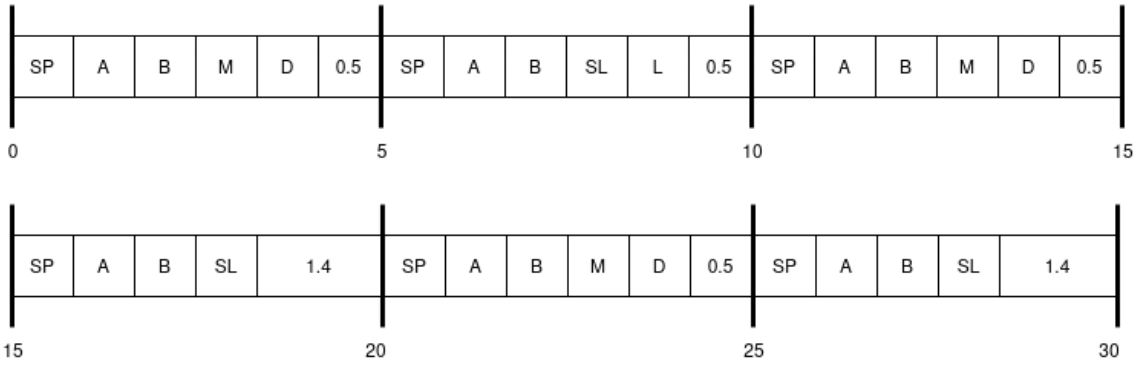
Notice that Read Speed, Accelerator On/Off and Brake On/Off tasks' periods are now 5 seconds.

CPU usage, main and secondary cycles:

$$U = 3 * (0.9/5) + 3 * (0.9/10) + 0.9/30 = 0.84 < 1$$

$$MC = mcm(5, 10, 30) = 30 \qquad SC = min(Ti) = 5$$

Cyclic Scheduler:



STOP MODE

The periods are already harmonic:

ORIGINAL	T=D	C
RL: Read Loading	5	0.9
M: Mixer On/Off	15	0.9
L: Lamps On/Off	5	0.9

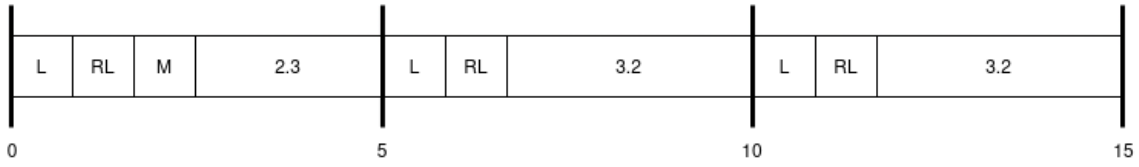
T=5 was chosen for the Read Loading task, since it makes this task run with a high frequency.

CPU usage, main and secondary cycles:

$$U = (0.9/15) + 2 * (0.9/5) = 0.42 < 1$$

$$MC = mcm(5, 15) = 15 \qquad SC = min(Ti) = 5$$

Cyclic Scheduler:



SECTION D

Arduino module

EMERGENCY MODE SCHEDULER

ORIGINAL	T/D (ms)	C (ms)
CS: Communication Server	200	9.368
A: On/Off Accelerator	100	0.016
B: On/Off Break	100	0.016
M: On/Off Mixer	100	0.016
S: Compute and show speed	100	0.128
RS: Read slope	100	0.012
L: On/Off Lamps	100	0.008

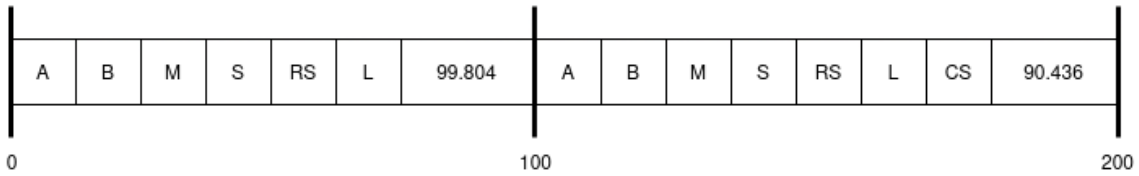
Communication server includes the compute time for the functions that handle requests. T=100 was chosen arbitrarily for most tasks; it is a valid period, smaller than 200 and conveniently makes all periods harmonic.

CPU usage, main and secondary cycles:

$$U = 9.368/200 + (3 * 0.016 + 0.128 + 0.012 + 0.008)/100 = 0.0488 < 1$$

$$MC = mcm(200, 10) = 200 \qquad SC = min(Ti) = 100$$

Cyclic Scheduler:



Software module

EMERGENCY MODE

We will reduce the periods to make it harmonic:

ORIGINAL	T=D	C
SL: Read Slope	10	0.9
SP: Read Speed	10	0.9
A: Accelerator On/Off	10	0.9
B: Brake On/Off	10	0.9
M: Mixer On/Off	15	0.9
L: Lamps On/Off	6	0.9
EM: Emergency Mode	10	0.9

REDUCED	T=D	C
SL: Read Slope	10	0.9
SP: Read Speed	10	0.9
A: Accelerator On/Off	10	0.9
B: Brake On/Off	10	0.9
M: Mixer On/Off	10	0.9
L: Lamps On/Off	5	0.9
EM: Emergency Mode	10	0.9

T=10 was chosen for the Emergency Mode task, since it makes this task run with a reasonable frequency and provides a quick response to an emergency.

CPU usage, main and secondary cycles:

$$U = (0.9/5) + 6 * (0.9/10) = 0.72 < 1$$

$$MC = mcm(5, 10) = 10 \qquad SC = min(Ti) = 5$$

Cyclic Scheduler: