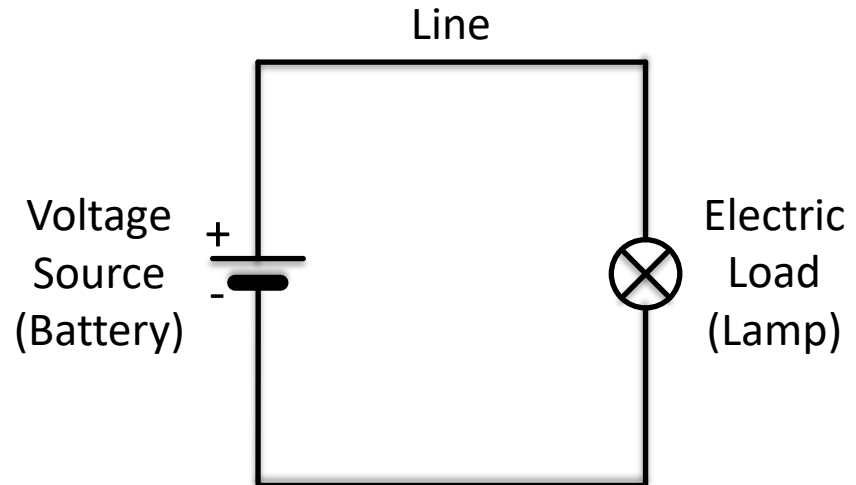# Electric Circuits

## Networks and Embedded Systems

### First Grade Level

Wolfgang Neff

# Electric Circuit (1)

- Structure
  - Voltage source
    - Battery
  - Electric Load
    - Lamp
  - Electrical wiring
    - Line
    - Cable

Line

Voltage
Source
(Battery)

Electric
Load
(Lamp)

+

-

# Electric Circuit (2)

- Basics
  - Voltage source
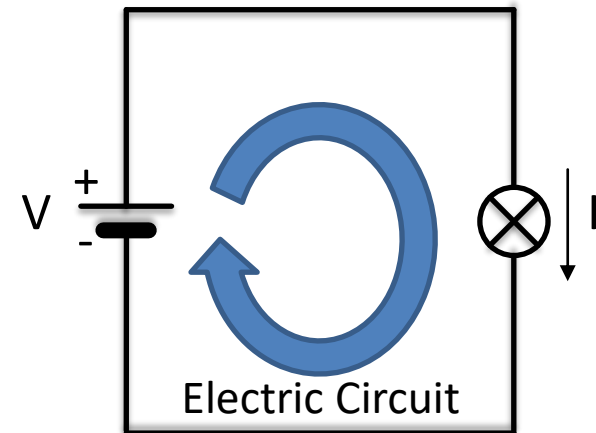    - A voltage is applied
    - Voltage V, [V] (Volt)
  - Electric Load
    - A current flows through
    - Electric current I, [A] (Ampere)
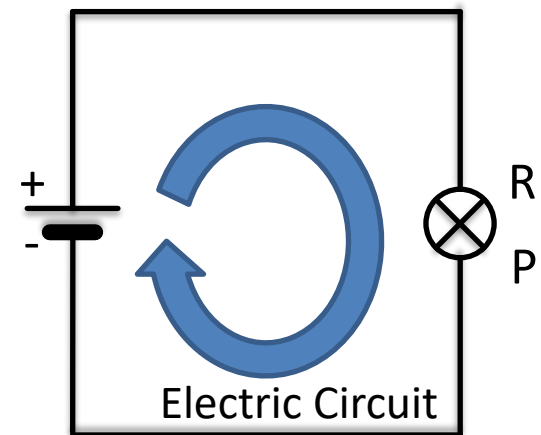  - Conventional direction of current
    - The current flows from plus (+) to minus (-)

Unit

V $^+_-$

Electric Circuit

I

# Electric Circuit (3)

- Electric Circuit
  - Resistor
    - A load hinders the current
    - Resistance R, [Ω] (Ohm)
  - Power
    - A load consumes power
    - Power P, [W] (Watt)
  - Formulas
    - $R = \dfrac{V}{I}, \;\; P = V \cdot I$



R
P

Electric Circuit

# Electric Circuit (4)

- Exercise
  - If a voltage of 5 V is applied to a lamp and a current of 20 mA flows through it
  - What is the resistance of the lamp?
    - $R = \dfrac{V}{I} = \dfrac{5\,V}{20\,mA} = \dfrac{5\,V}{0.02\,A} = 250\,\Omega$
  - What power is consumed?
    - $P = V \cdot I = 5\,V \cdot 20\,mA = 5V \cdot 0.02\,A = 0.1\,W$
    - $P = 0.1\,W = 100\,mW$

# Electric Circuit (5)

- Rules of Thumb
  - The current flows from plus (+) to minus (-)
  - Current is measured at a point
    - It flows through this point
    - It flows for example through a load
  - Voltage is measured between two points
    - It is applied at these points
    - Often one of these points is ground
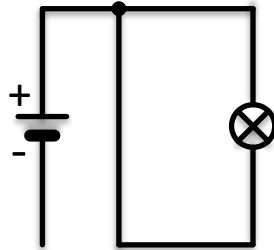      - Ground, GND → 0 V

# Electric Circuit (6)

- ## Rules of Thumb
  - ### Electric Current can flow only if …
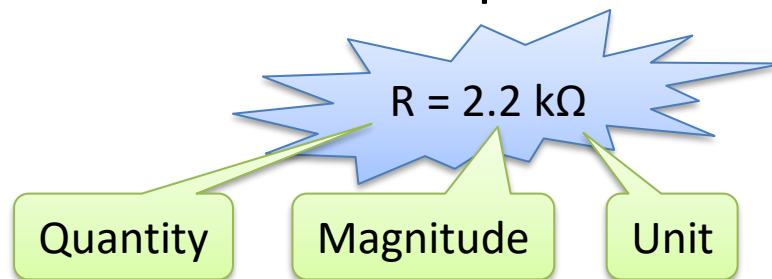    - … the electric circuit is closed
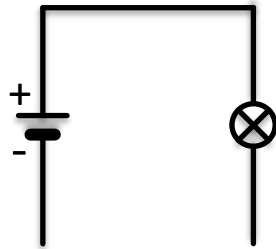


    - … there is a voltage difference
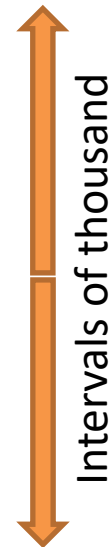
# Unit Prefixes (1)

- Physical quantities
  - Have a magnitude
    - Should not have more than three digits
    - Should not have a decimal point
      - Exception: Circuit Diagrams (e. g. 2k2)
  - Have a unit
    - Prefixes are used to respect these rules

R = 2.2 kΩ

Quantity     Magnitude     Unit

# Unit Prefixes (2)

- Decimal unit prefixes  (SI)
  - In technical applications powers of three are used
    - Centi and deci are usually not used

| Text | Symbol | Value | Factor | Power |
|---|---|---|---|---|
| Giga | G | Billion | 1 000 000 000 | $10^9$ |
| Mega | M | Million | 1 000 000 | $10^6$ |
| Kilo | k | Thousand | 1 000 | $10^3$ |
| - | - | One | 1 | $10^0$ |
| Milli | m | Thousandth | 0.001 | $10^{-3}$ |
| Micro | μ | Millionth | 0.000 001 | $10^{-6}$ |
| Nano | n | Billionth | 0.000 000 001 | $10^{-9}$ |

Intervals of thousand

# Unit Prefixes (3)

- Binary unit prefixes (IEC)
  - One uses powers of 1024
    - $2^{10} = 1024 \rightarrow$ Quite close to 1000
  - There are texts and symbols of it's own
    - But they are seldom used

| Text | Symbol | Factor | Power | Power |
|------|--------|-------:|-------|-------|
| Gibi | Gi | 1 073 741 824 | $1024^3$ | $2^{30}$ |
| Mebi | Mi | 1 048 576 | $1024^2$ | $2^{20}$ |
| Kibi | Ki | 1 024 | $1024^1$ | $2^{10}$ |
| - | - | 1 | $1024^0$ | $2^0$ |