Binary Logic Levels

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Getting Started Rules

- All signals are ***really analog*** and not digital
- Logic circuits require direct current (DC) power to function
- Signals are represented by a direct current (DC) voltage
- The binary value zero (0) is represented by a low voltage and the binary value one (1) is represented by a high voltage
- Do not connect an output to another output
- There are a limited number of inputs than can be connected to a single output (for TTL, that number is usually ten)
  - This is referred to as the **fan-out**
- Signals exhibit noise and vary over time
- Do not depend on the value of a signal when it is possibly changing state from high to low or from low to high

Power Supply to TTL Logic Circuits

- TTL is an acronym for Transistor-Transistor Logic
- TTL was the initial fundamental logic family used in digital Integrated Circuits (ICs)

- Supply Voltage = 5V DC
  - Called V_{CC} for bipolar junction transistor (BJT) (NPN and PNP transistor) logic families
- Ground = 0V DC
  - Called GND
  - Also called V_{EE} for bipolar junction transistor (BJT) (NPN and PNP transistor) logic families

- Elementary logic circuits are called "gates"
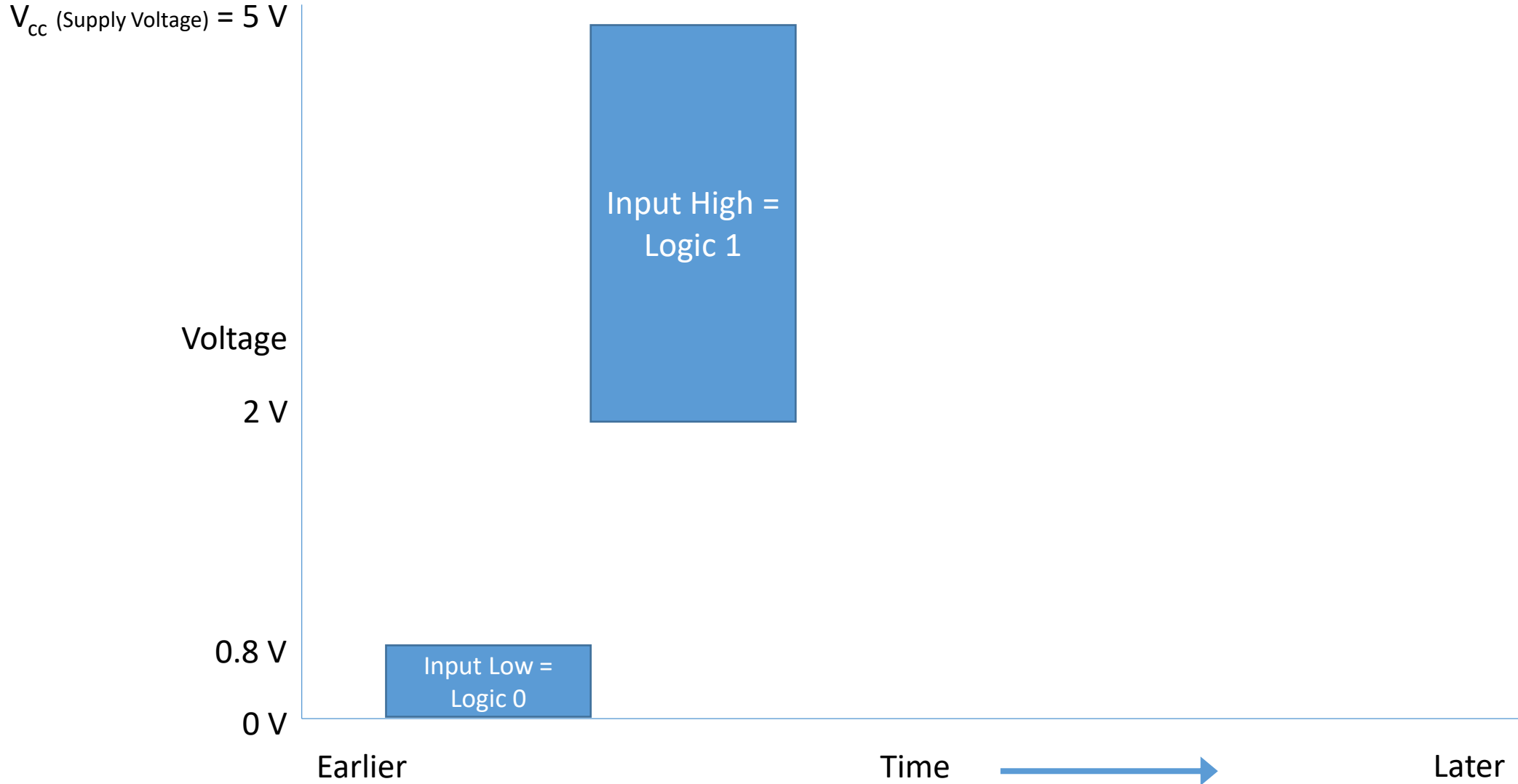- Today, most circuits use CMOS logic

Power Supply to CMOS Logic Circuits

- CMOS is an acronym for Complementary Metal-Oxide-Semiconductor
- Uses complementary pairs of P-type and N-type Metal Oxide Semiconductor Field Effect Transistors (MOSFETs)
- Supply Voltage = 5V DC, 3.3V DC (fairly common), 2.4V DC, 1.8V DC, 1.2V DC
  - Called V_{DD} for CMOS logic families
- Ground = 0V DC
  - Called V_{SS} for CMOS logic families

- We'll be examining voltage levels used by the TTL family in more detail
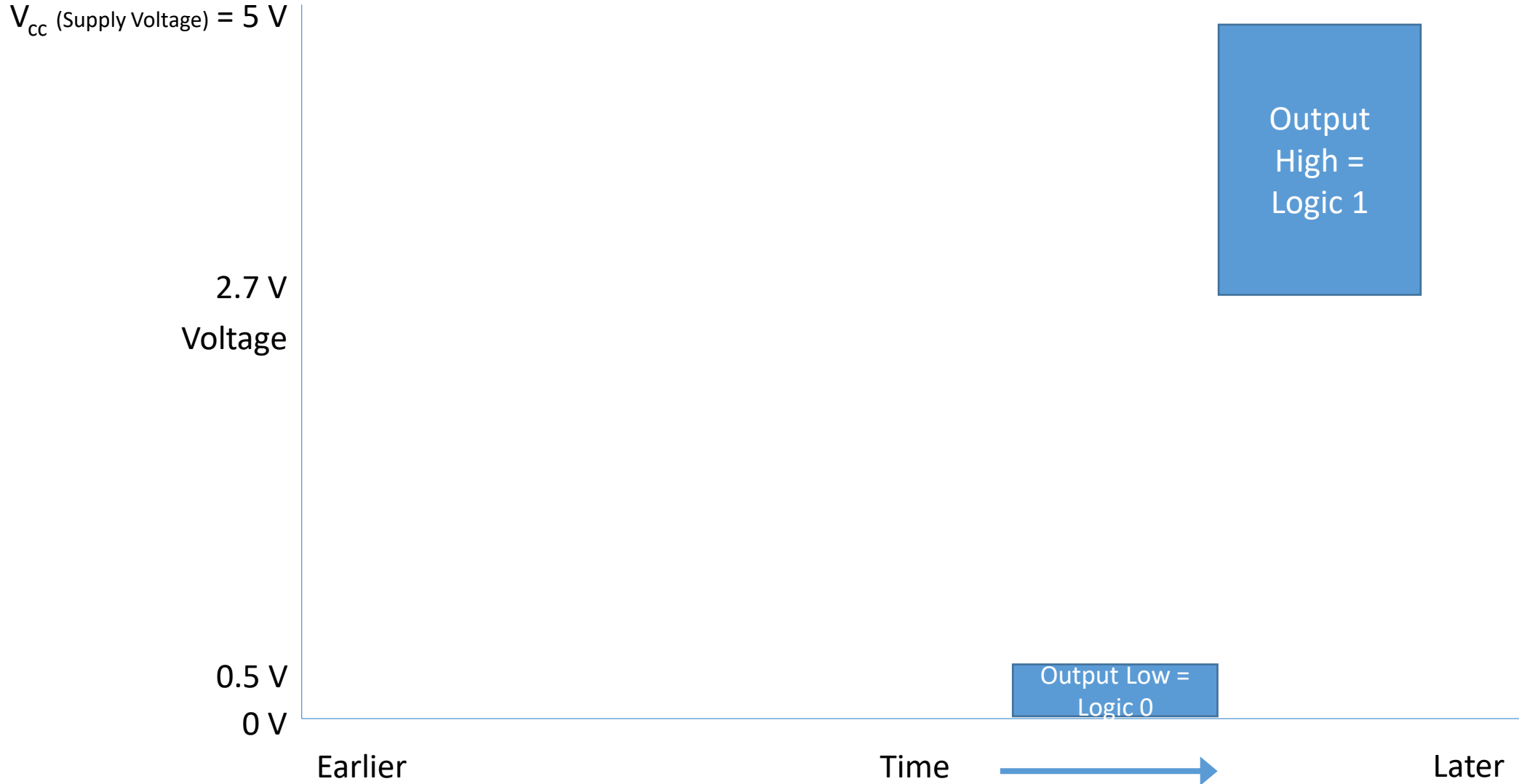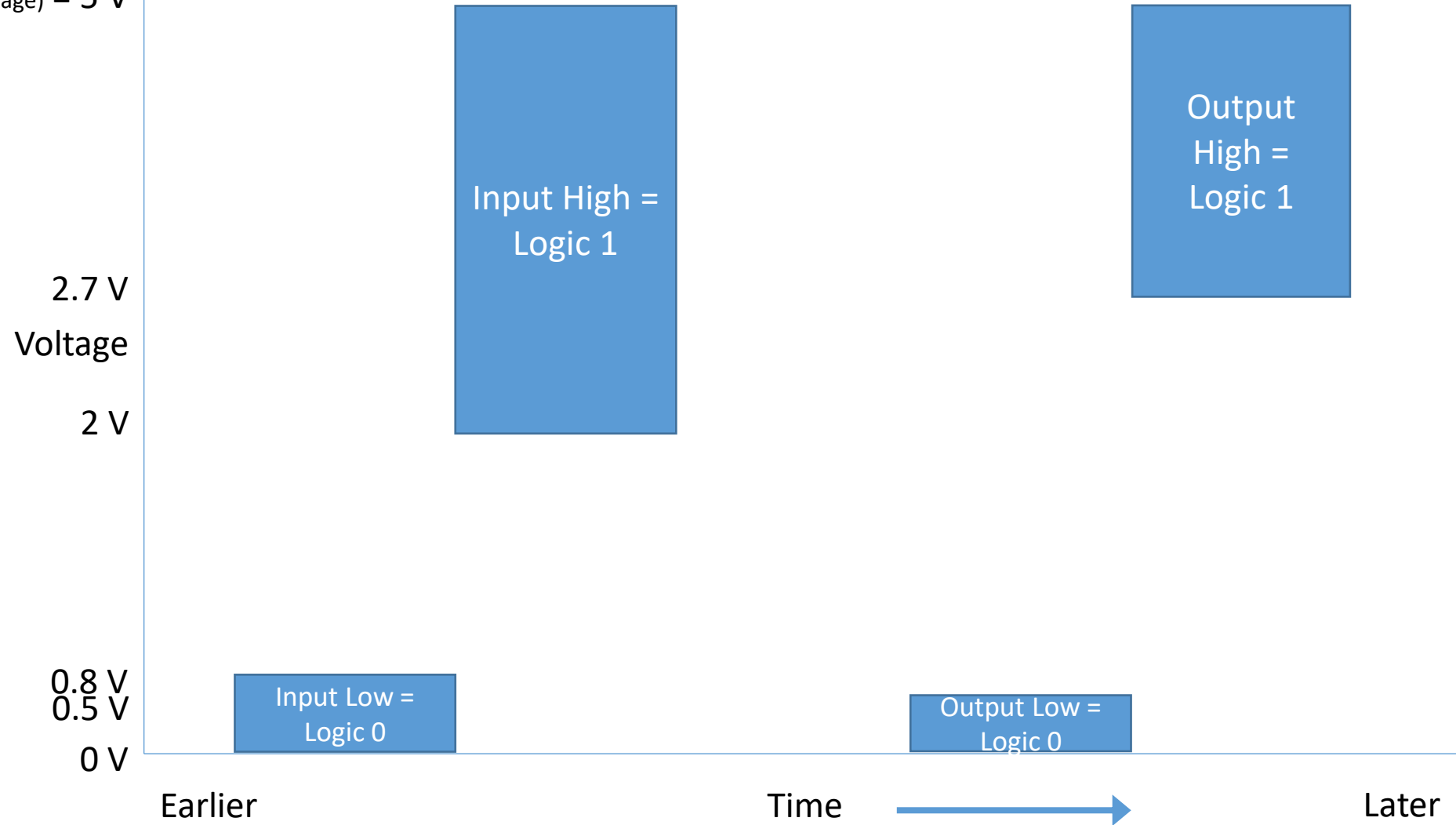
Connections Among Logic Elements
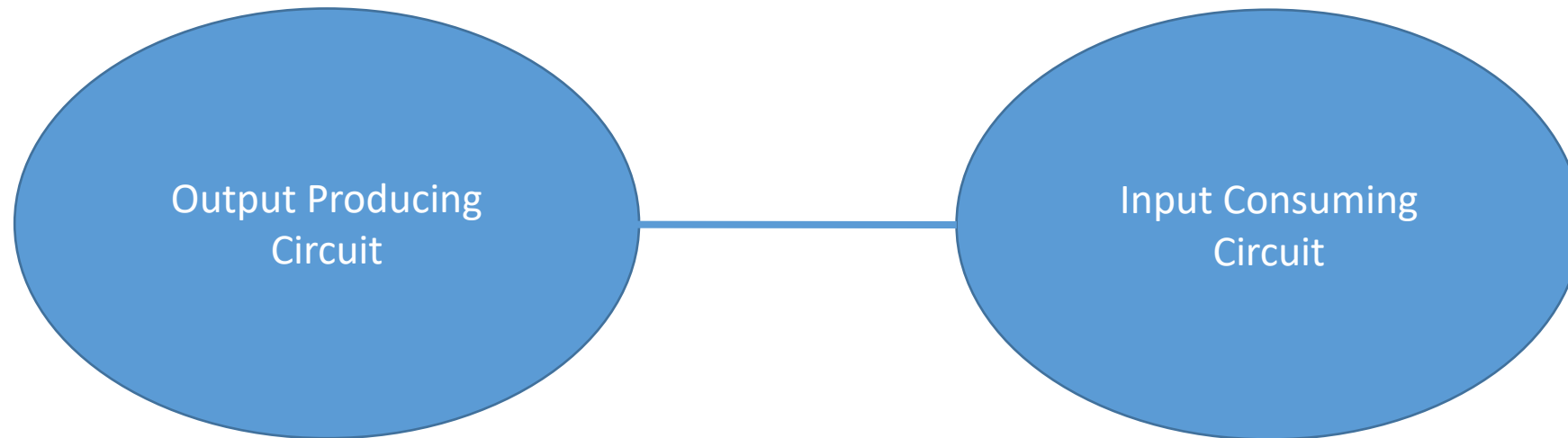
Acceptable Input Voltages in TTL

V_{CC} (Supply Voltage) = 5 V

Voltage
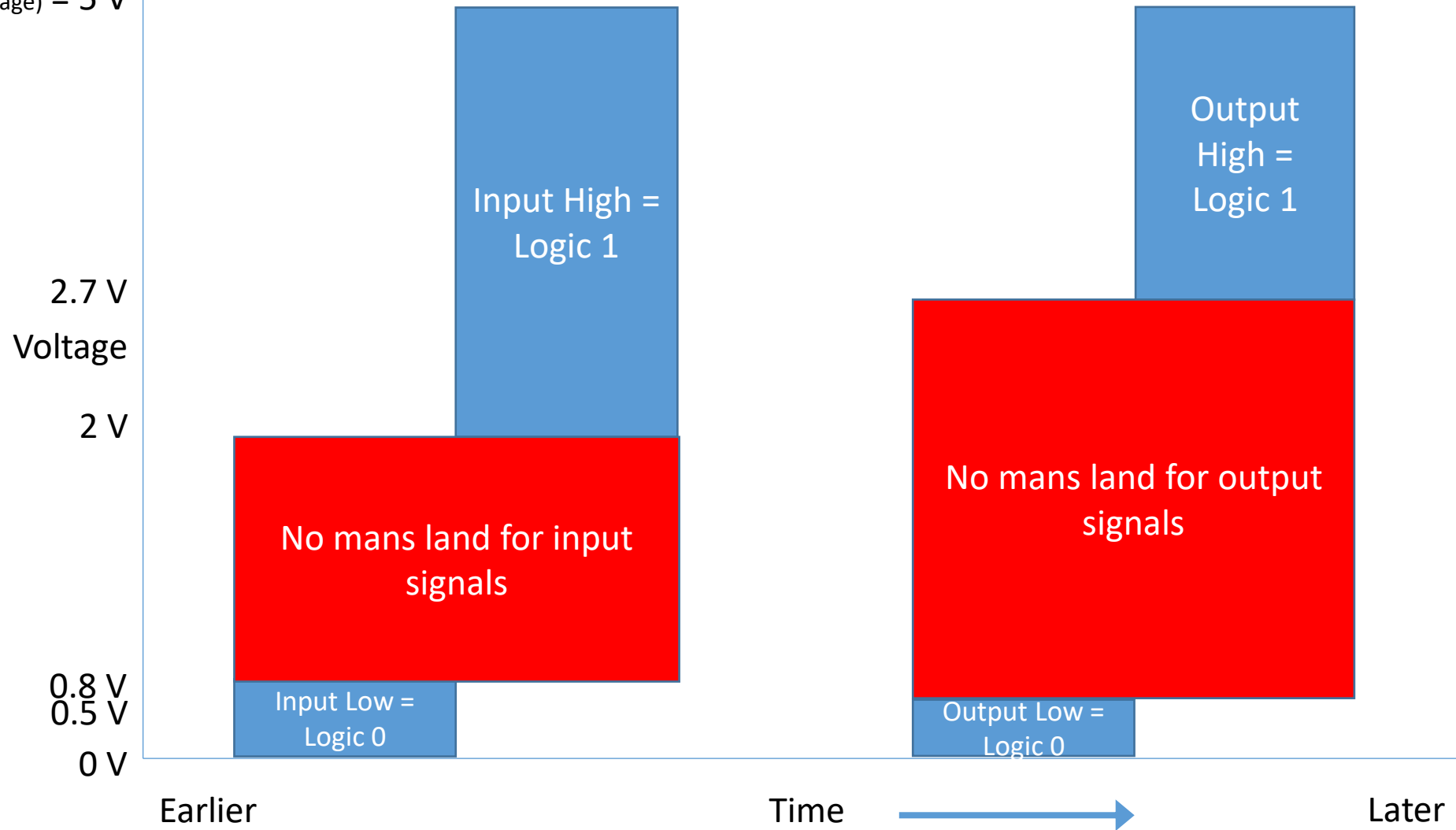
Input High =
Logic 1

2 V

0.8 V

Input Low =
Logic 0

0 V

Earlier

Time

Later

Acceptable Output Voltages in TTL

V_{cc} (Supply Voltage) = 5 V

2.7 V

Voltage

Output High = Logic 1

0.5 V

0 V

Output Low = Logic 0

Earlier

Time

Later

V_{CC} (Supply Voltage) = 5 V

Voltage

2.7 V

2 V

0.8 V
0.5 V

0 V

Input High =
Logic 1

No mans land for input
signals

Input Low =
Logic 0

Output
High =
Logic 1

No mans land for output
signals

Output Low =
Logic 0

Earlier

Time

Later

V$_{CC}$ (Supply Voltage) = 5 V

2.7 V

Voltage

2 V

0.8 V
0.5 V

0 V

Input High =
Logic 1

Noise Margin

No mans land for input
signals

Output
High =
Logic 1

No mans land for output
signals

Noise Margin

Input Low =
Logic 0

Output Low =
Logic 0

Earlier

Time

Later

Review of TTL Binary Logic Levels

- Supply Voltage = V_{CC} = 5V
- Ground = GND = 0V
- Input Low Logic Levels: 0V – 0.8V
- Input High Logic Levels: 2V – 5V
- Output Low Logic Levels: 0V – 0.5V
- Output High Logic Levels: 2.7V – 5V