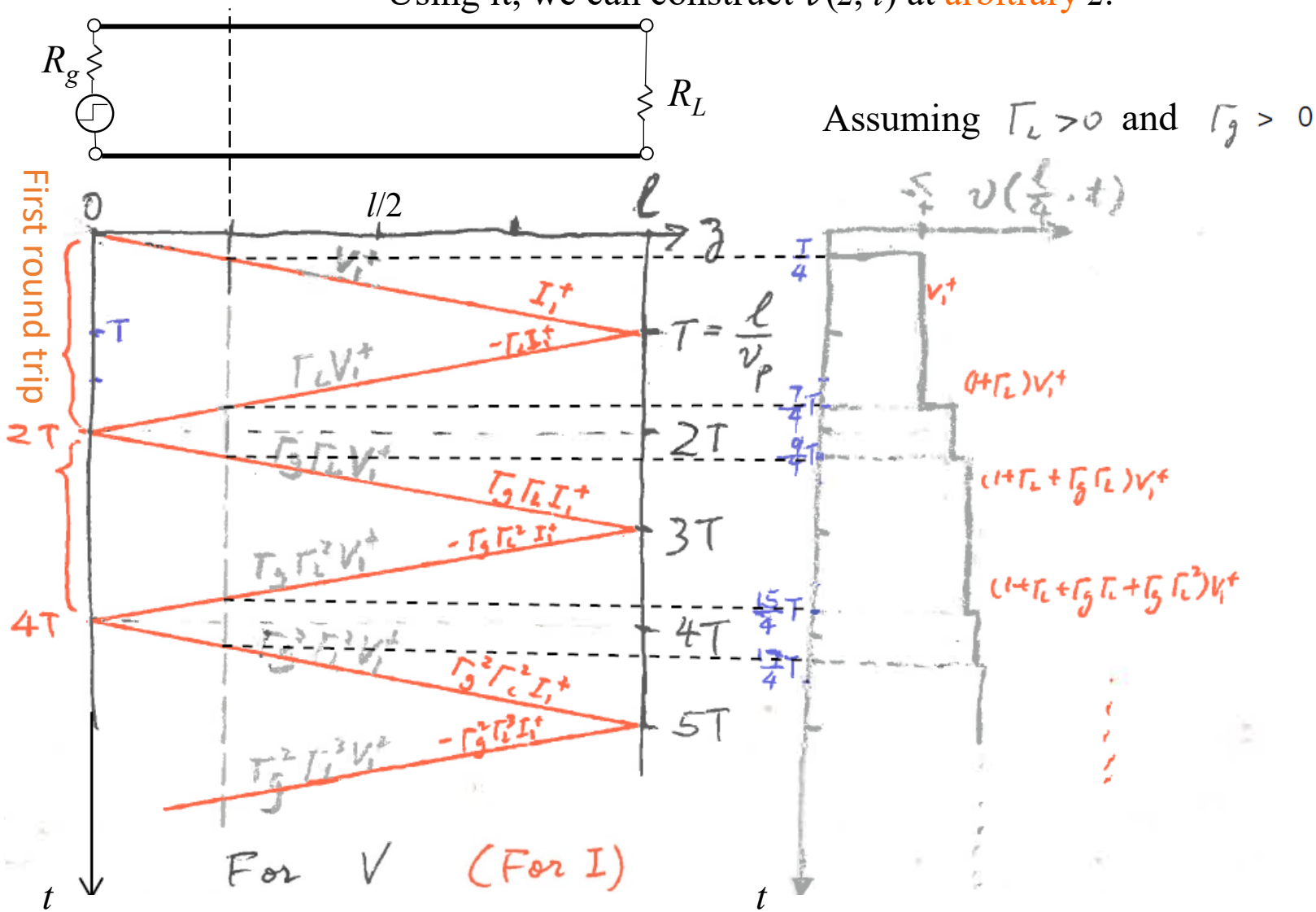
Bounce Diagram

A graphic tool to help us do the bookkeeping.
Using it, we can construct $v(z, t)$ at arbitrary z.



Similarly, you can construct a plot for $i(z,t)$. That will look a bit different.
It is not monotonic, due to the – signs.

The v and i each converge to their respective steady-state values.

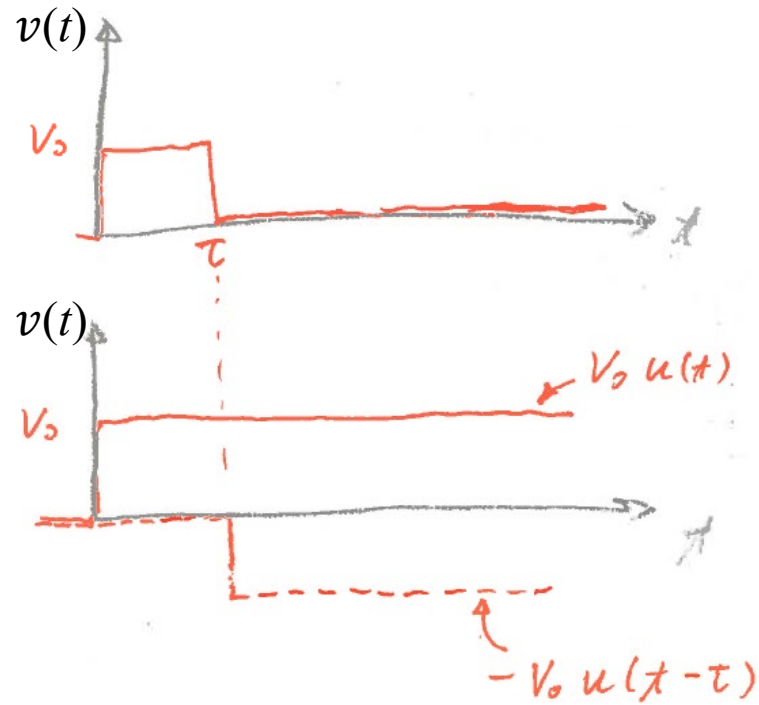
A step delivers only 1 bit of information.

We send pulses to deliver lots of bits.

What we really care is how a pulse, not a step, will bounce back and forth.

A pulse is the superposition of two steps:

$$\text{Pulse}(t) = V_0 \left[\underbrace{u(t)}_{\text{Step function}} - u(t-\tau) \right]$$



The transmission line system is linear.

The response to the superposition of two steps is the superposition of the two responses.

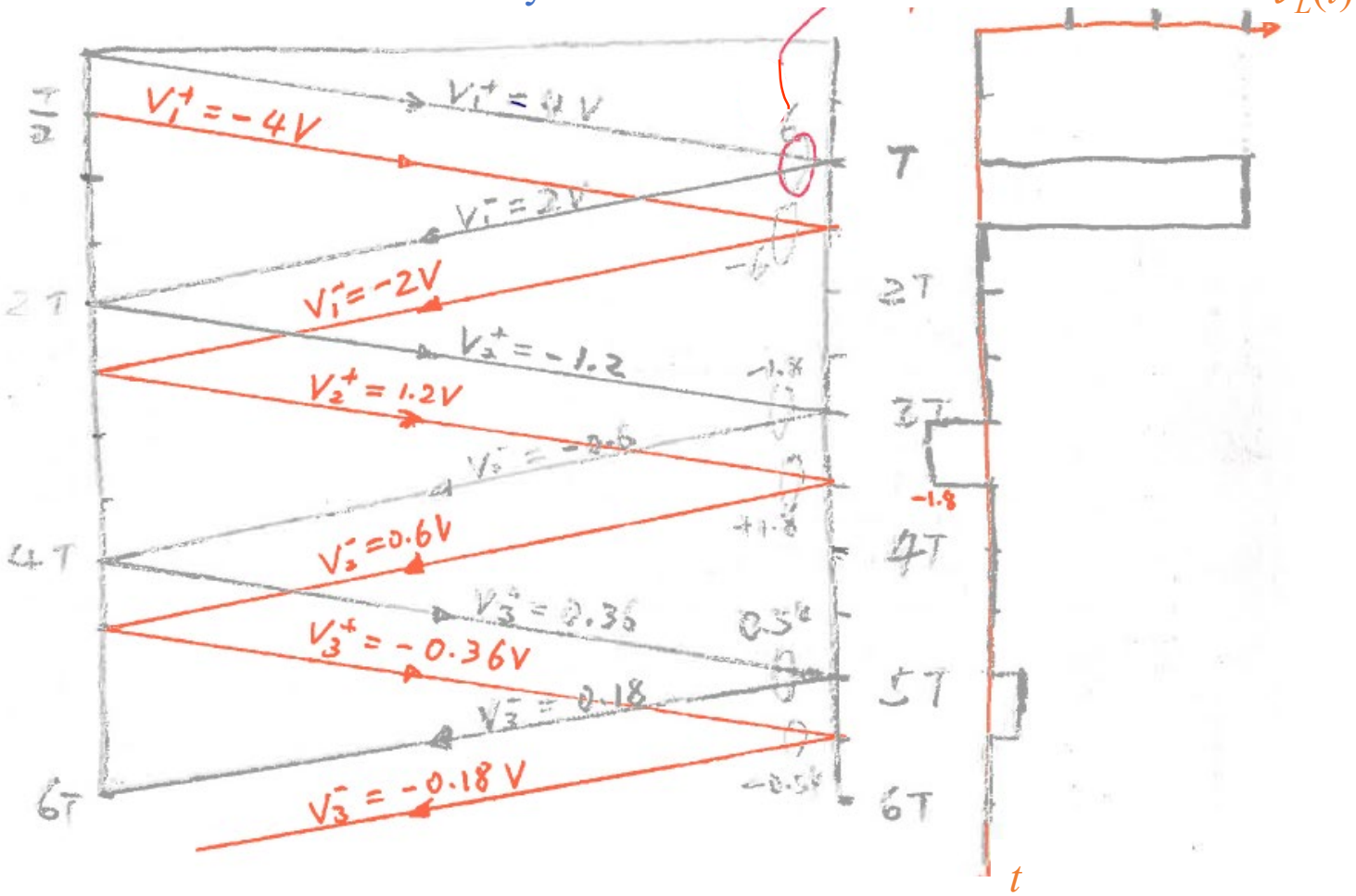
This justifies what we will do next.

A specific example (with numeric values) to show how we trace the echoes of a pulse using the bounce diagram:

$\Gamma_L = 0.5$, $\Gamma_g = -0.6$, $\tau = \frac{T}{2}$ $V_1^+ = 4V$

Plot $v_L(t)$

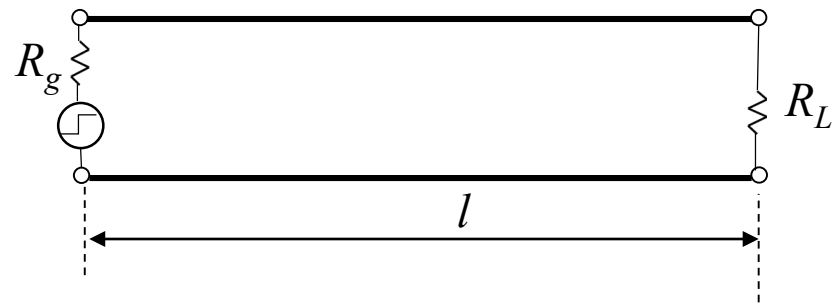
Pay attention to the value



What is the steady-state value?

Review textbook Section 2-12.2. Finish Homework 6.

Let's consider some real-world situations.



$$v_p = (2/3)c = 2 \times 10^8 \text{ m/s}$$

$$R_L = R_g = 3Z_0 \implies \Gamma_L = \Gamma_g = 1/2$$

$$v(l, (2n+1)T) = V_1^+ \left(1 + \frac{1}{2}\right)\left[1 + \frac{1}{4} + \frac{1}{4^2} + \frac{1}{4^3} + \cdots + \frac{1}{4^n}\right]$$

$$4^5 = 1024$$

After $(2 \times 5 + 1)T = 11T$, the voltage load is already almost settled to the steady state.

$$l = 2 \text{ m} \implies T = 10^{-8} \text{ s} = 10 \text{ ns} \implies 11T = 0.11\mu\text{s}$$

$$l = 200 \text{ m} \implies T = 10^{-6} \text{ s} = 1 \ \mu\text{s} \implies 11T = 11\mu\text{s}$$

The transient happens "fast"!

But if you are sending "bits" of information (pulses), the voltage of the *n*th echo, which is at $t = (2n+1)T$, is $(2/3)V_1^+/4^n$. You would say the echoes die down too slowly!