What is latency: a mini-masterclass

- Rebekah Wilson

Intro: What's in this talk

1. What is latency? A technical and historical overview
2. Latency and communications technology
3. The concept of Flow, and how it is disrupted by latency
4. Solutions and innovations to achieving flow in remote collaboration
5. The future: What innovations will come

Rebekah Wilson: Musician, composer, technologist

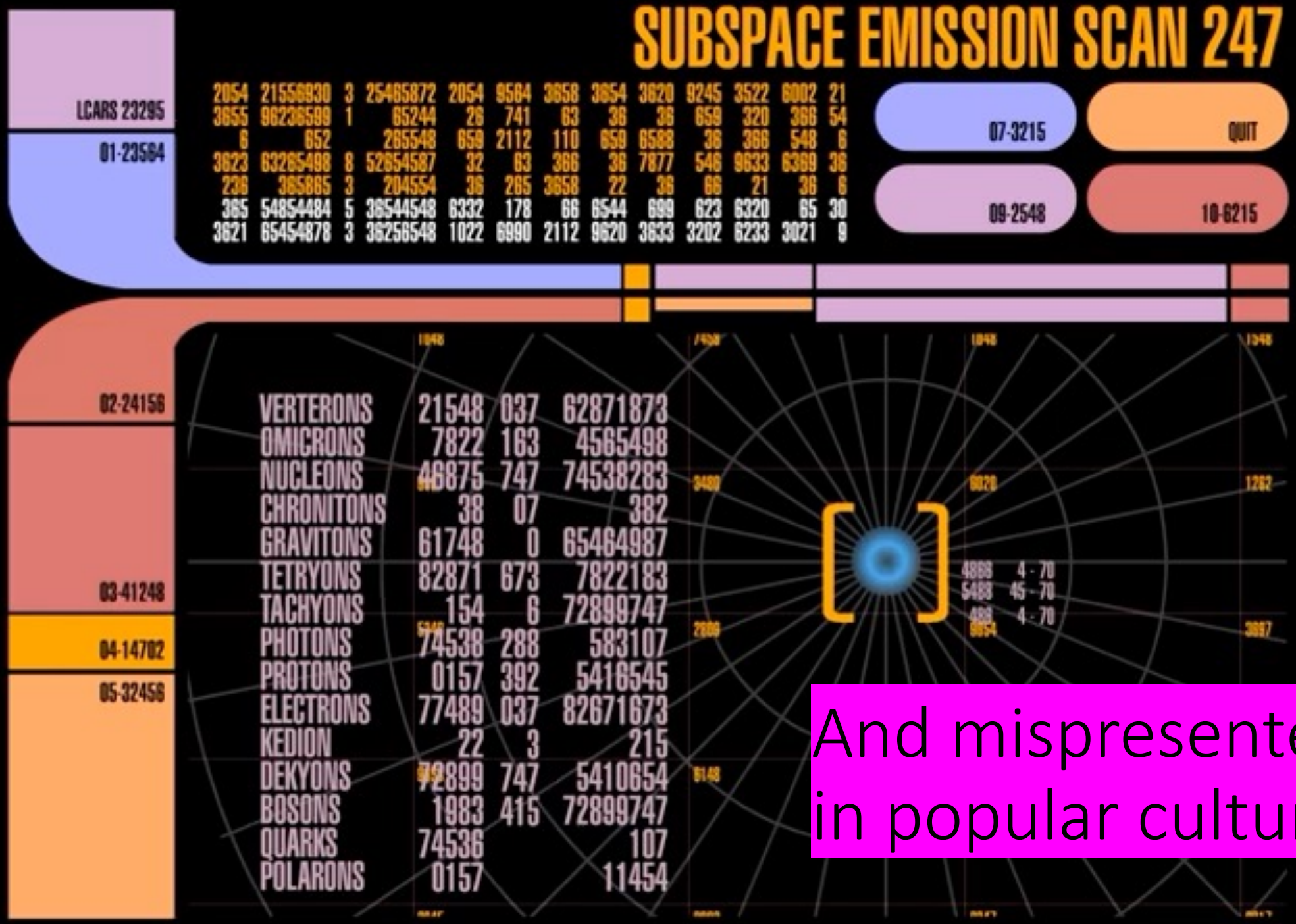
SOURCE ELEMENTS

CEO, technical co-founder Source Elements

Growing up the very-far-away islands of New Zealand drove her to be fascinated by how we communicate and collaborate over long distances

Latency is the delay that occurs due to the time it takes a signal to travel from one point to another

Latency isn’t new, but it is misunderstood



And mispresented in popular culture

Latency isn’t going anywhere according to our current knowledge of the physical universe

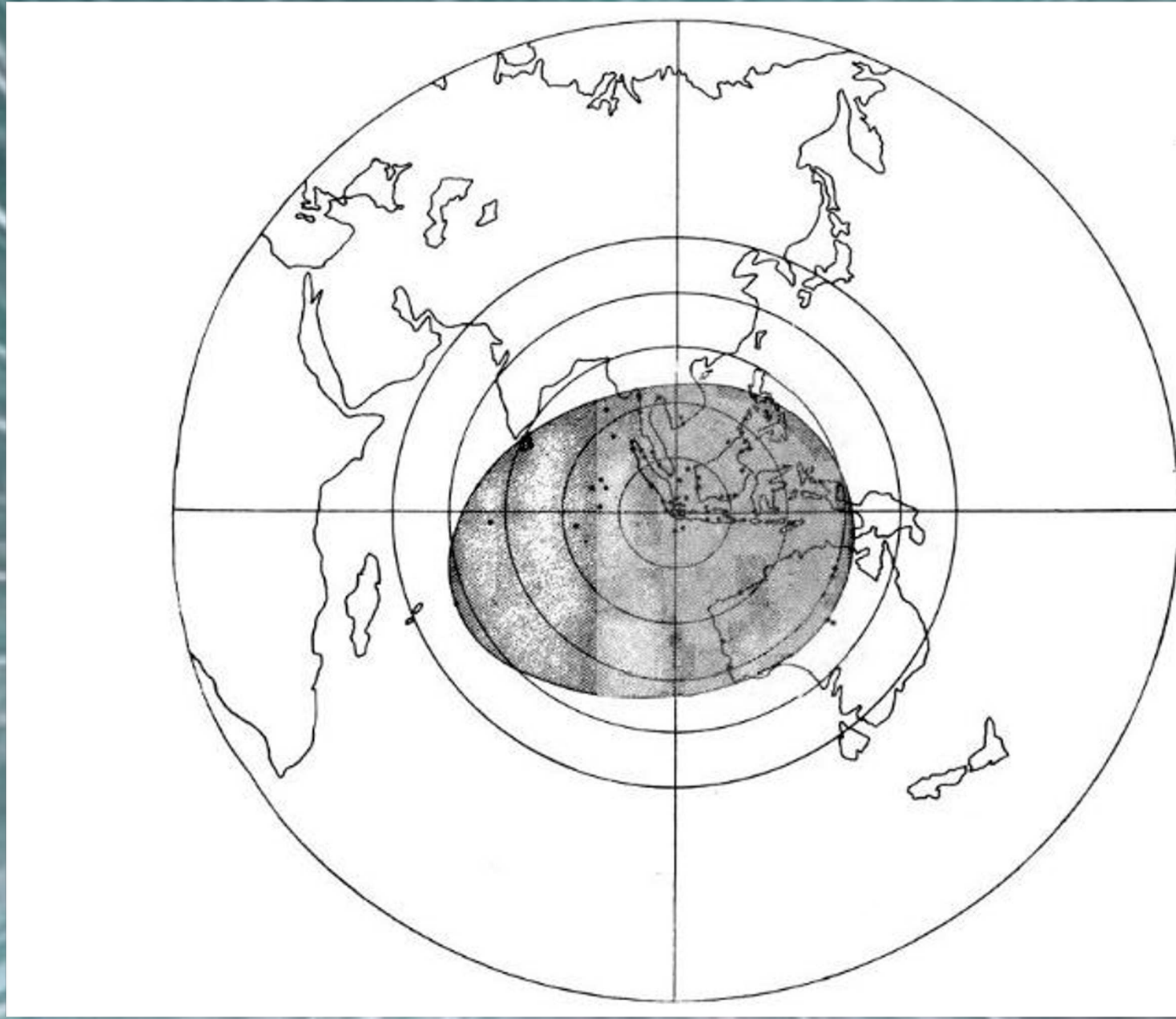
A history of latency

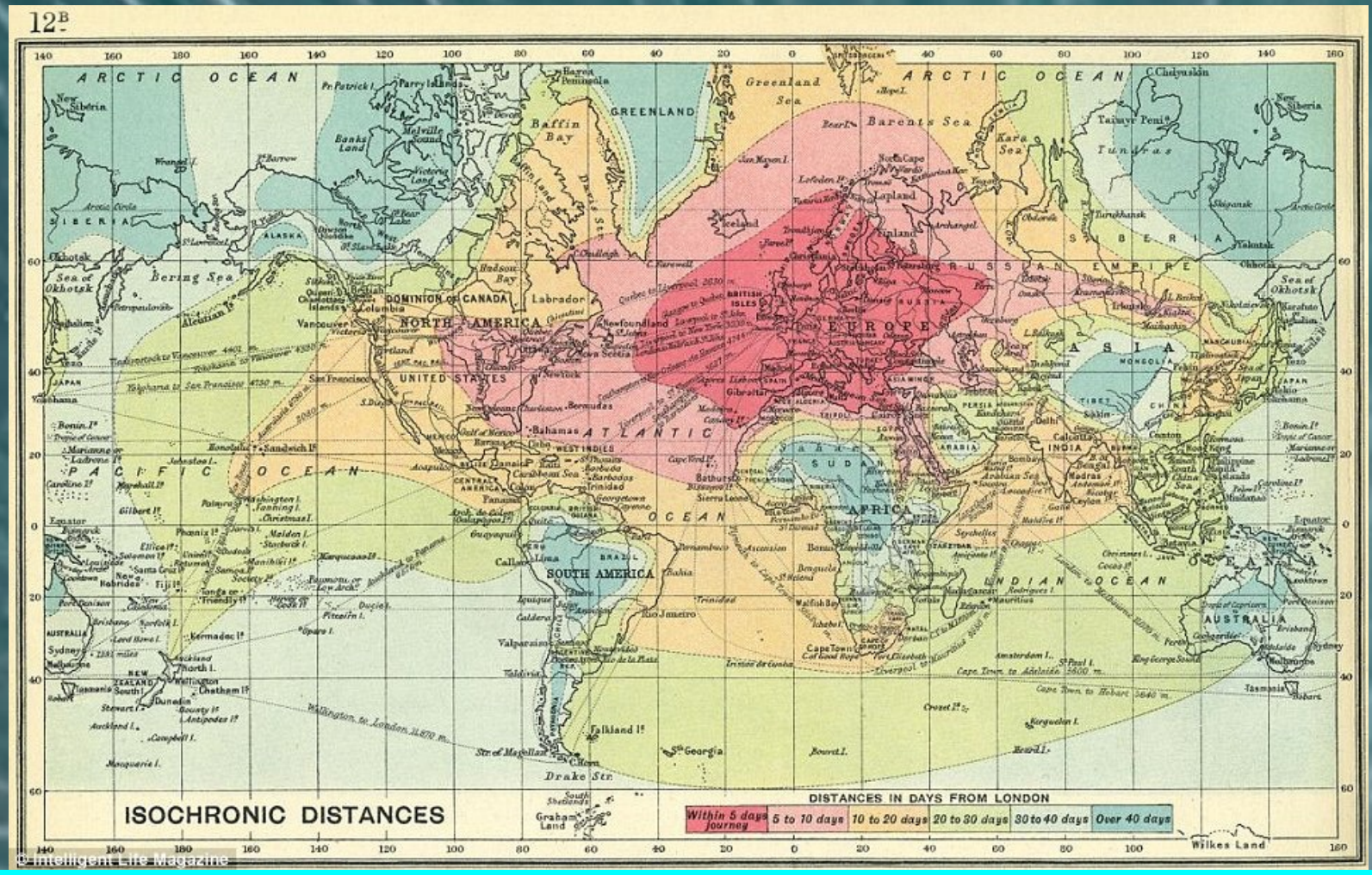
Krakatoa volcano explosion:

172 decibels heard

up to 5000 km away

– 4 hours travel time!





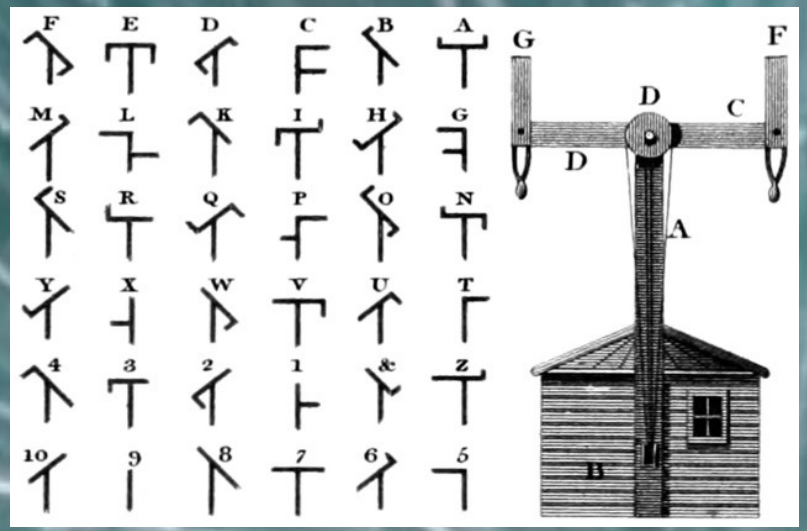
Isochronic distances have drastically shortened thanks to technology – time to send a letter a hundred years ago was measured in days and weeks, not milliseconds

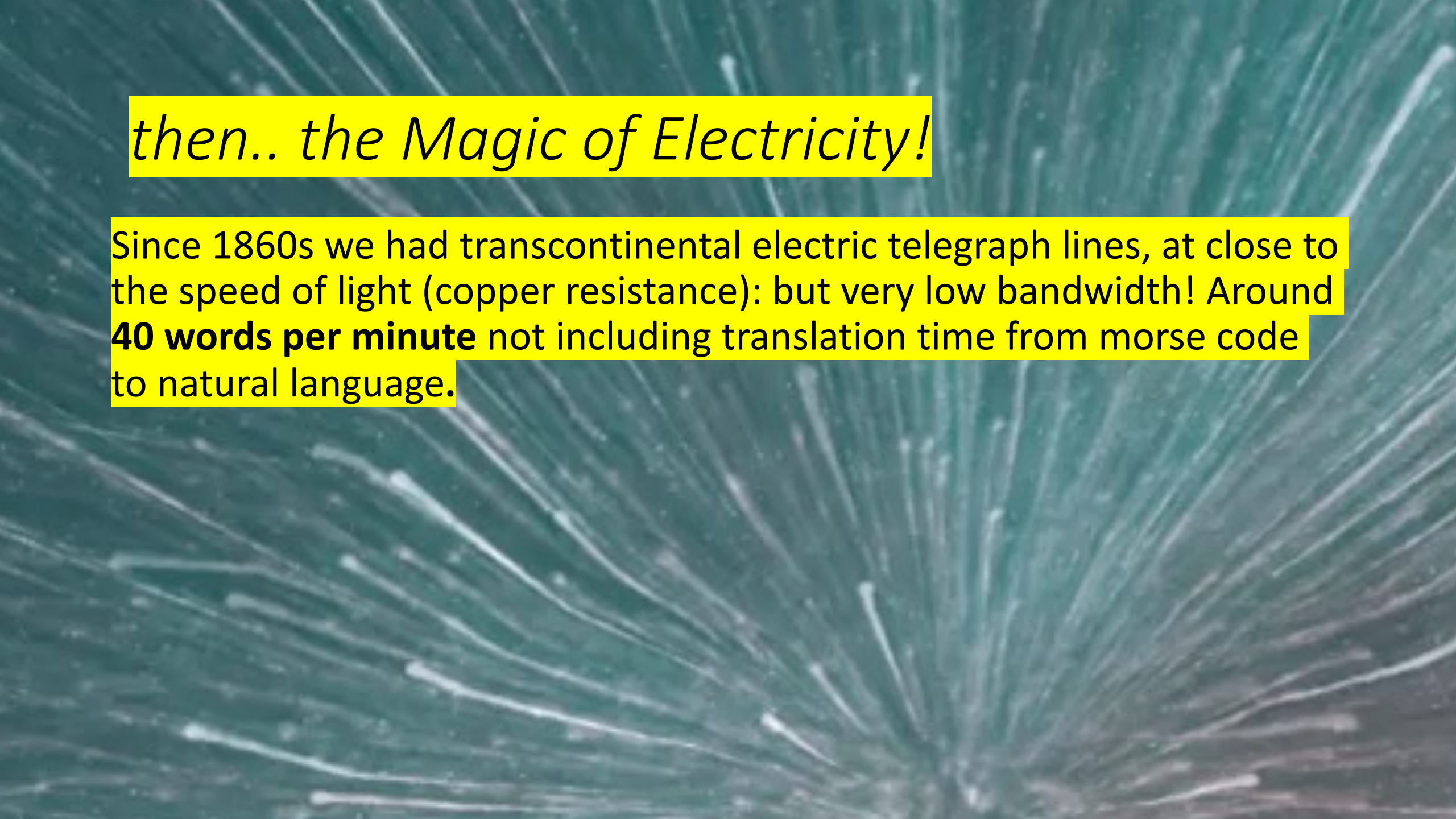
Even optical telegraph,

or semaphore signals

that were used in the 1700s ,

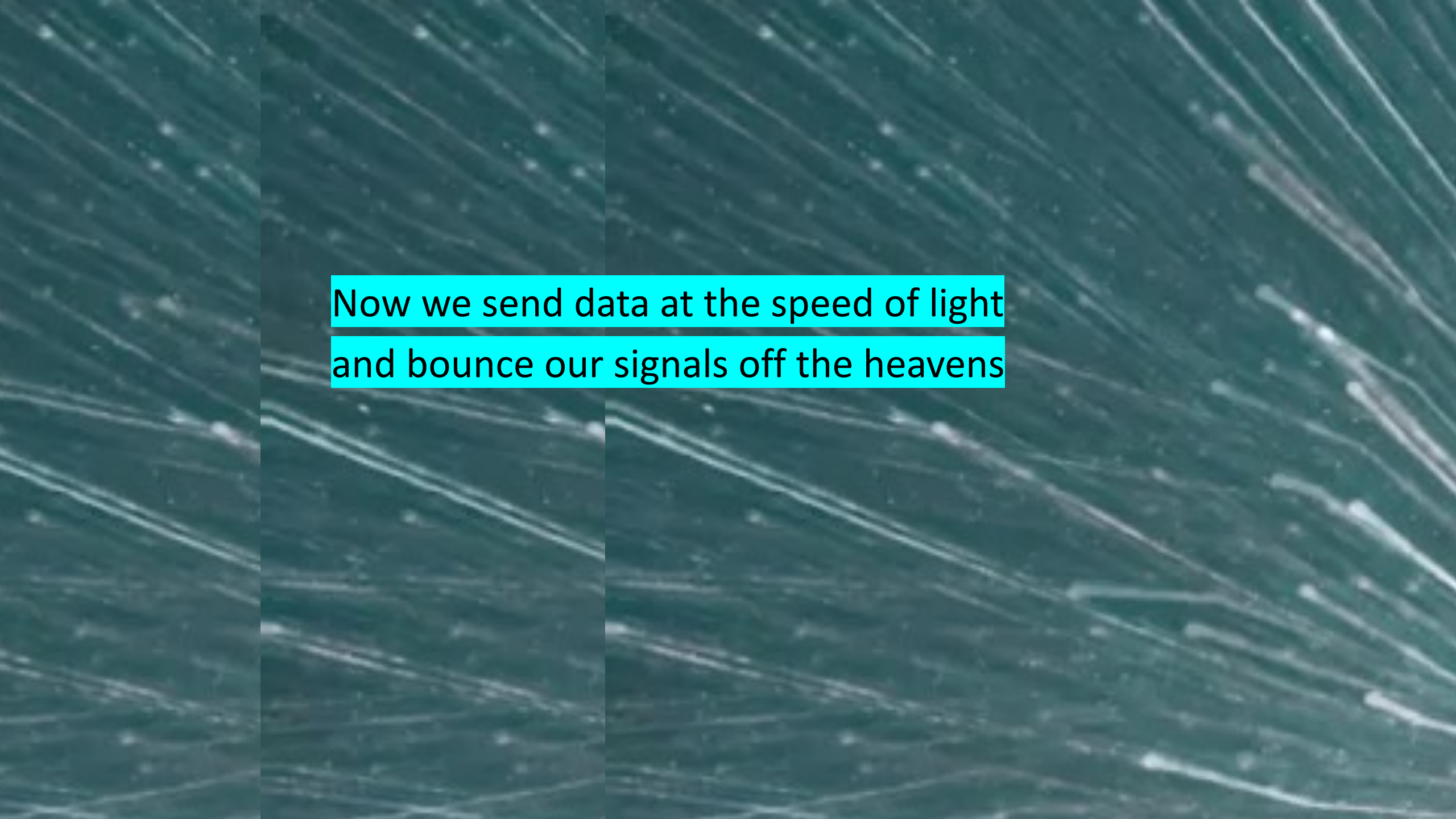
could only travel so quickly





then.. the Magic of Electricity!

Since 1860s we had transcontinental electric telegraph lines, at close to the speed of light (copper resistance): but very low bandwidth! Around **40 words per minute** not including translation time from morse code to natural language**.**


Now we send data at the speed of light
and bounce our signals off the heavens


Still, these are great distances

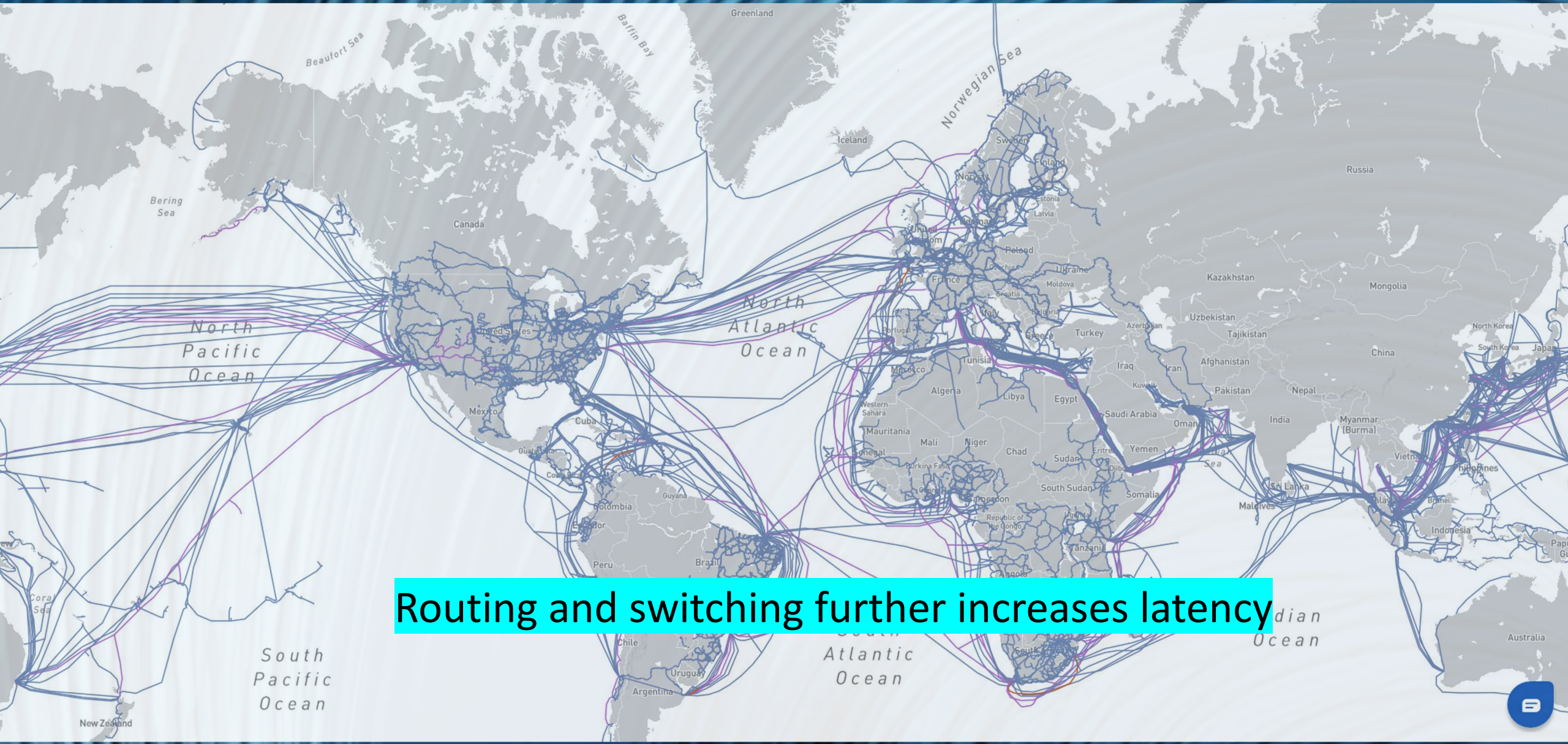
Speed of Light

7.5 orbits per second at surface

And even when data travels over light it is not real-time,

it's **near-real-time**

James O'Donoghue / NASA — T: @physicsJ IG: jameslikesspace



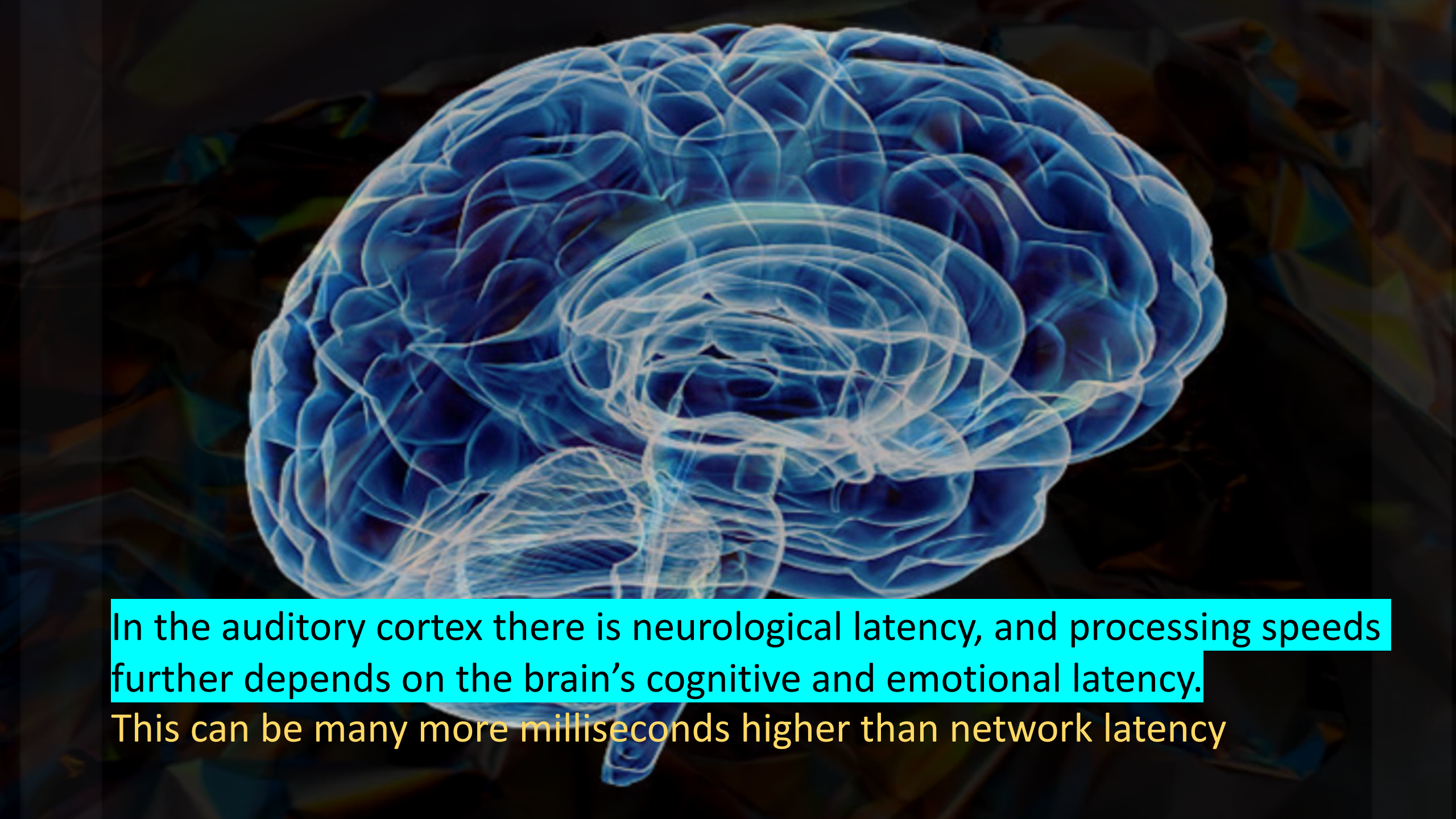
Routing and switching further increases latency

And it's not just transmission latency:

- we have physical latency,
- biological latency
- neurological latency
- emotional & cognitive latency
- hardware & software latency…

Biological latency is the time it takes for audio to be processed from physical air pressure from mechanical to electrical.

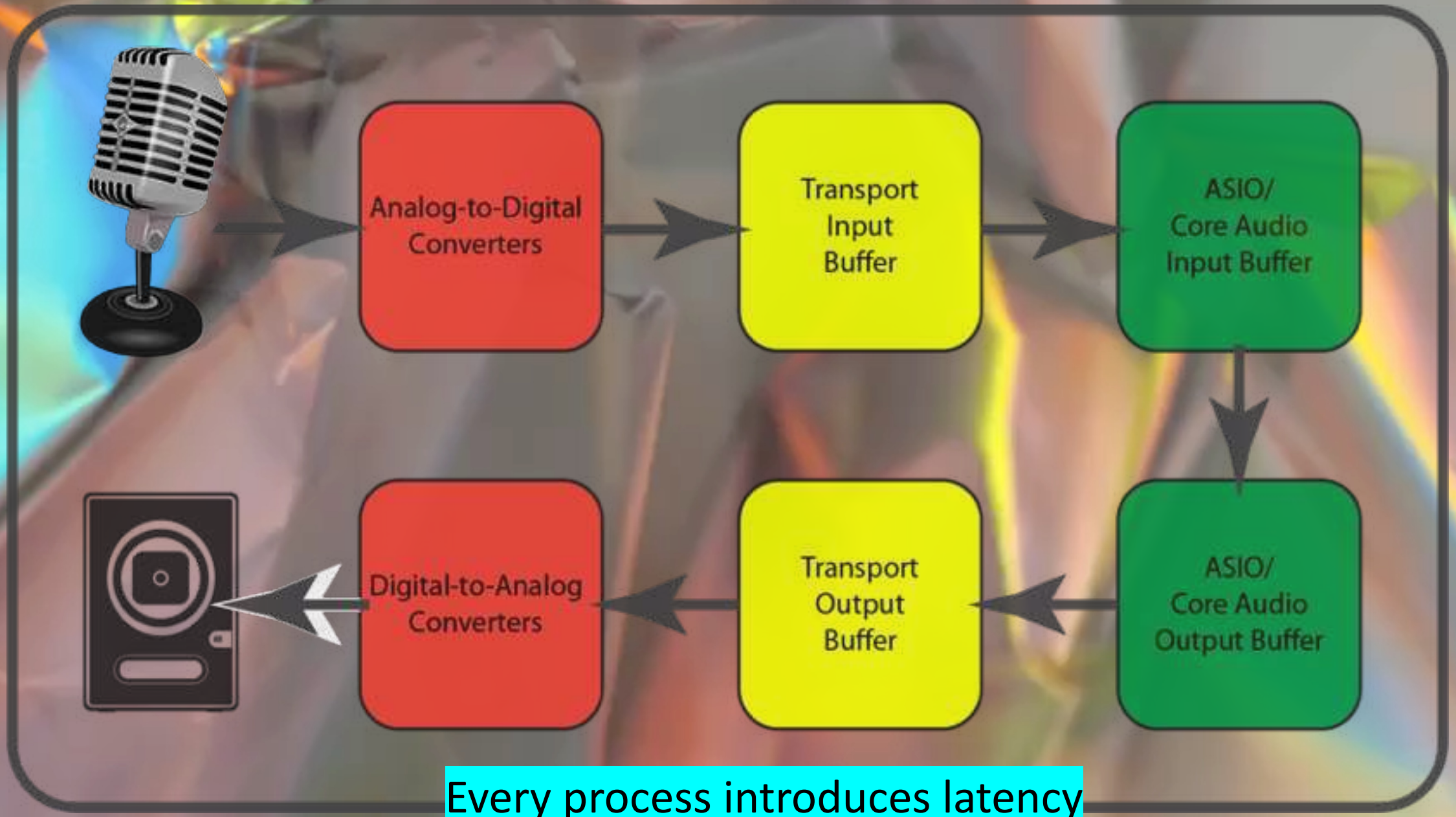
We evolved to accommodate for these, we don’t notice these milliseconds



In the auditory cortex there is neurological latency, and processing speeds further depends on the brain’s cognitive and emotional latency.

This can be many more milliseconds higher than network latency

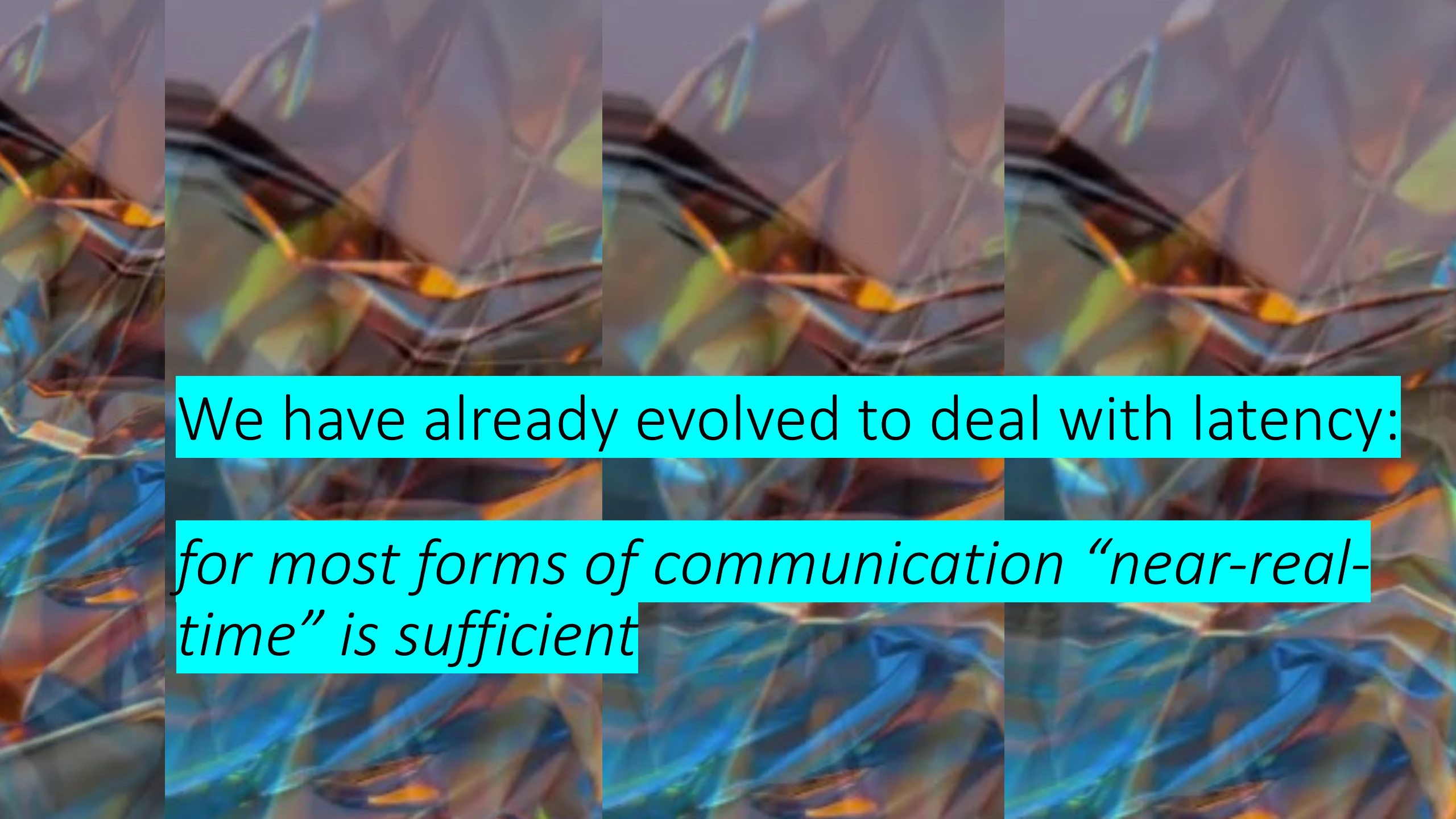

And there is hardware & software latency – each transformation needs time.
Consumer software or browsers can add an extra 30 ms!
UAC-2
USB3.0 Audio Converter
OUTPUT
PHONES



Every process introduces latency

Latency is found everywhere in communications technology

- Anytime a signal is transferred over distance
- Anywhere a signal changes the method of propagation
- Anytime we need to process information



We have already evolved to deal with latency:

for most forms of communication "near-real-time" is sufficient

Jitter is a terrible offender

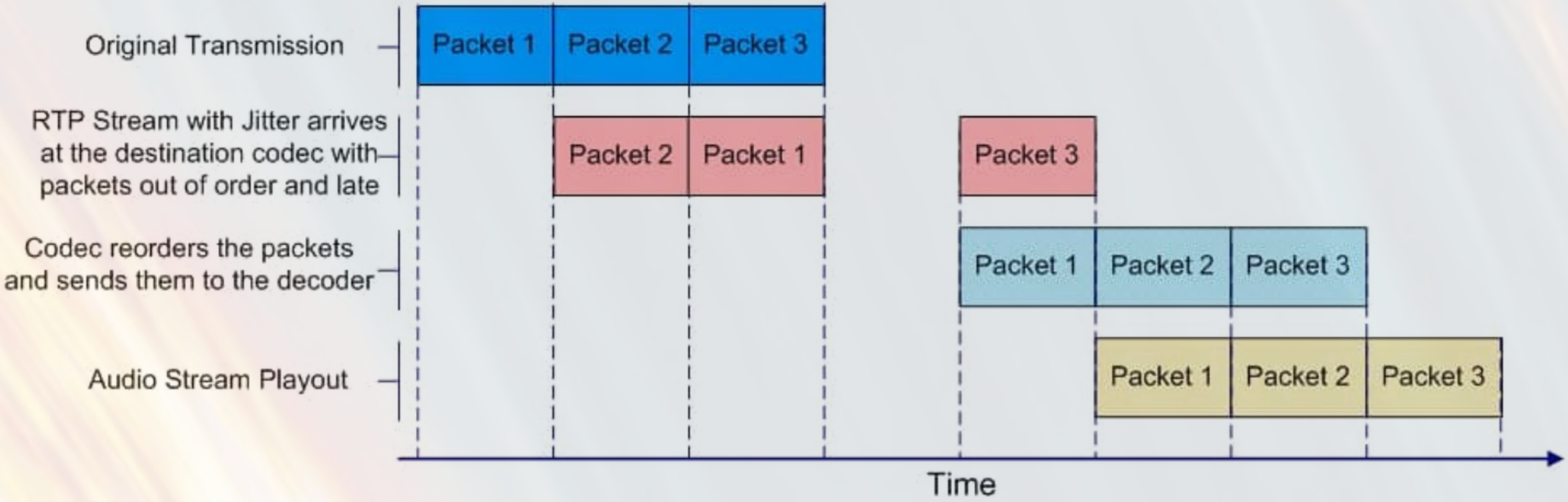
Congestion over packet networks leads to:

- packet loss due to insufficient bandwidth
- packet loss due to service outages and route changes

Leads to higher buffer requirements => higher latencies

And by design, there is no guarantee to deliver data over the Internet

(Image courtesy Google WaveNetEQ)



Too long a jitter buffer – too much latency.
Too little: packet loss. It's a delicate balance.

(Image courtesy Tieline)

Perception:

Latency is disruptive.

You can't play music over the Internet.

But humans are clever, we adjust for disruption constantly.

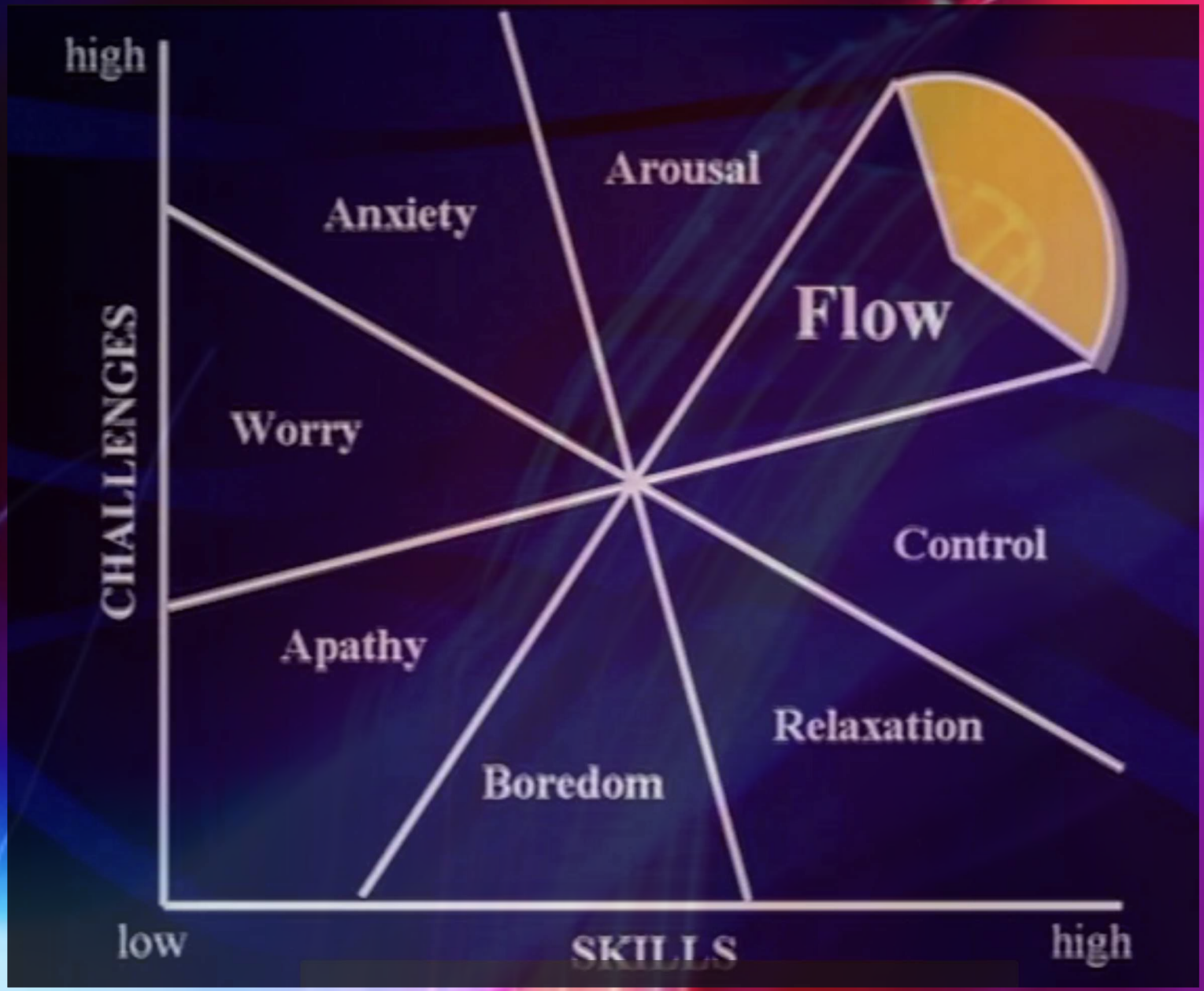
We listen to each other's rhythms and adjust constantly.

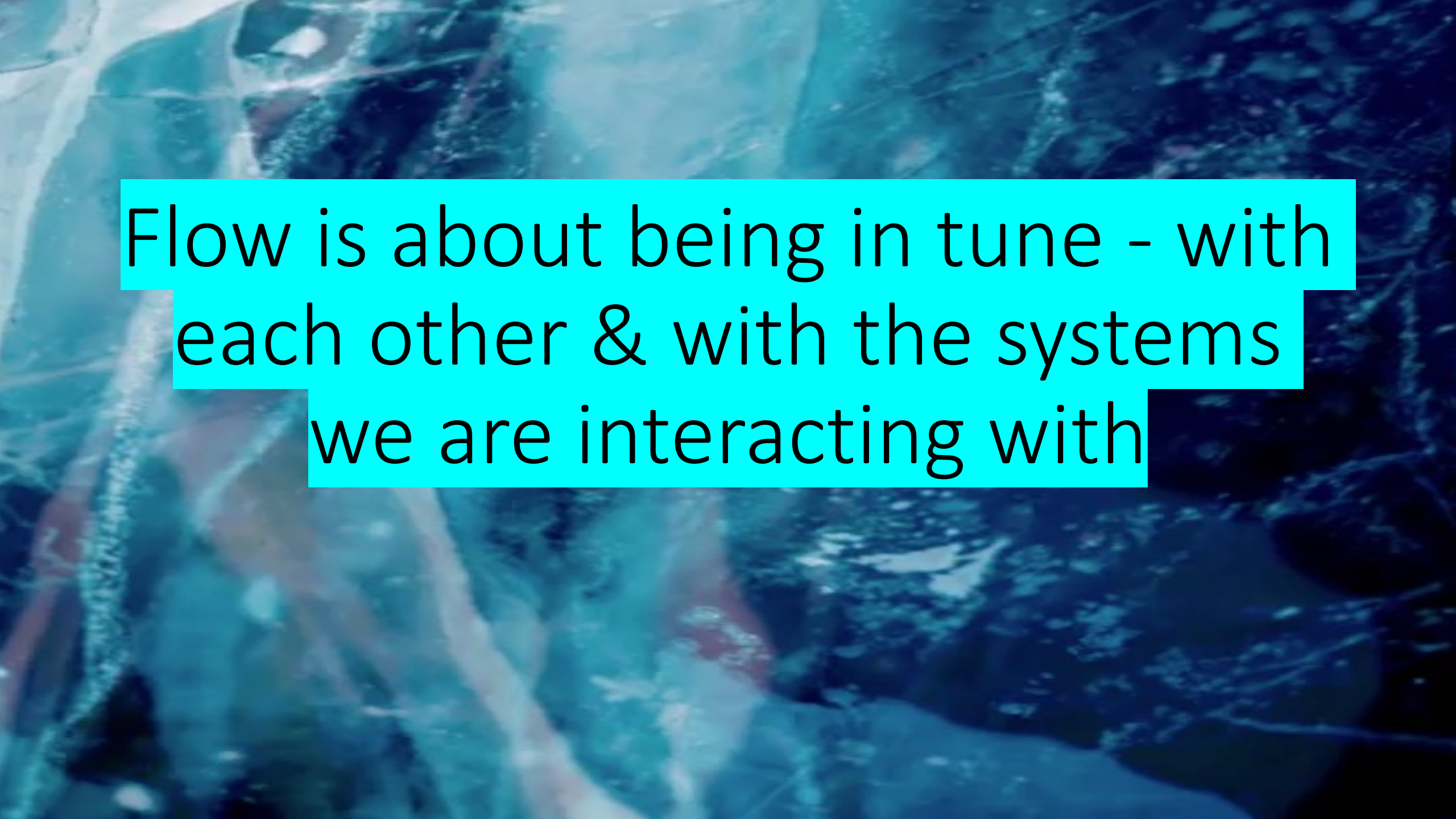
We find ways to maintain flow.

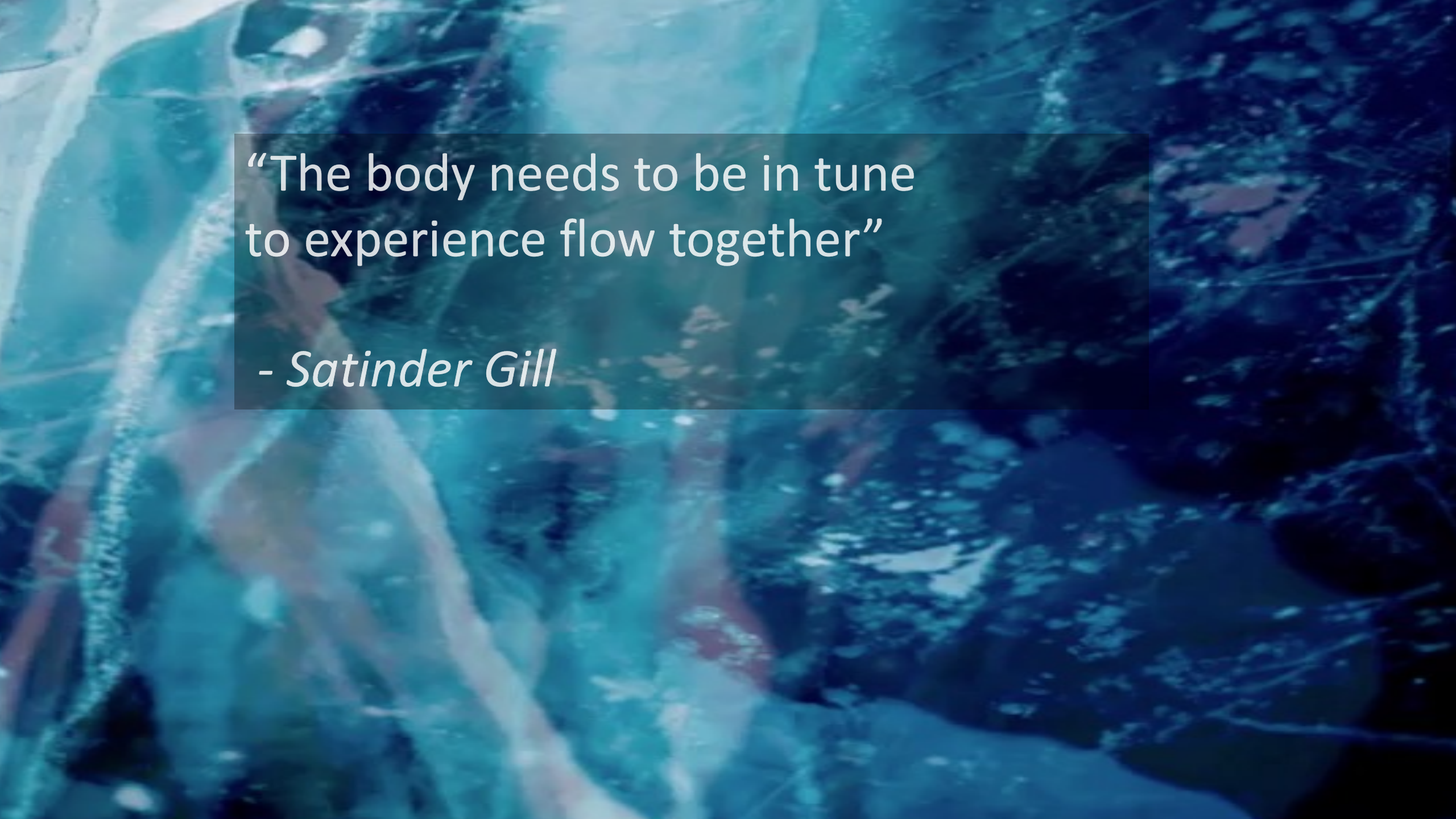
Flow is “**a state in which people are so involved in an activity that nothing else seems to matter**; the experience is so enjoyable that people will continue to do it even at great cost, for the sheer sake of doing it”

- Mihaly Csikszentmihalyi

Flow is closely related to control and relaxation - it is easily disrupted by anxiety and worry and boredom – packet loss, low quality communications and high latencies create this!


high
CHALLENGES
Anxiety
Arousal
Flow
Worry
Control
Apathy
Relaxation
Boredom
low
SKILLS
high


Flow is about being in tune - with each other & with the systems we are interacting with


“The body needs to be in tune
to experience flow together”
- Satinder Gill

Latency disrupts our flow –

technology-induced latency is new to our bodies

How do we manage the disruption to flow caused by latency in today’s communications tech?

Adapt our performance behaviour

Learn new rhythms


We cannot realistically further reduce latency over long distances
low enough for traditional real-time interactions

Technical solutions:

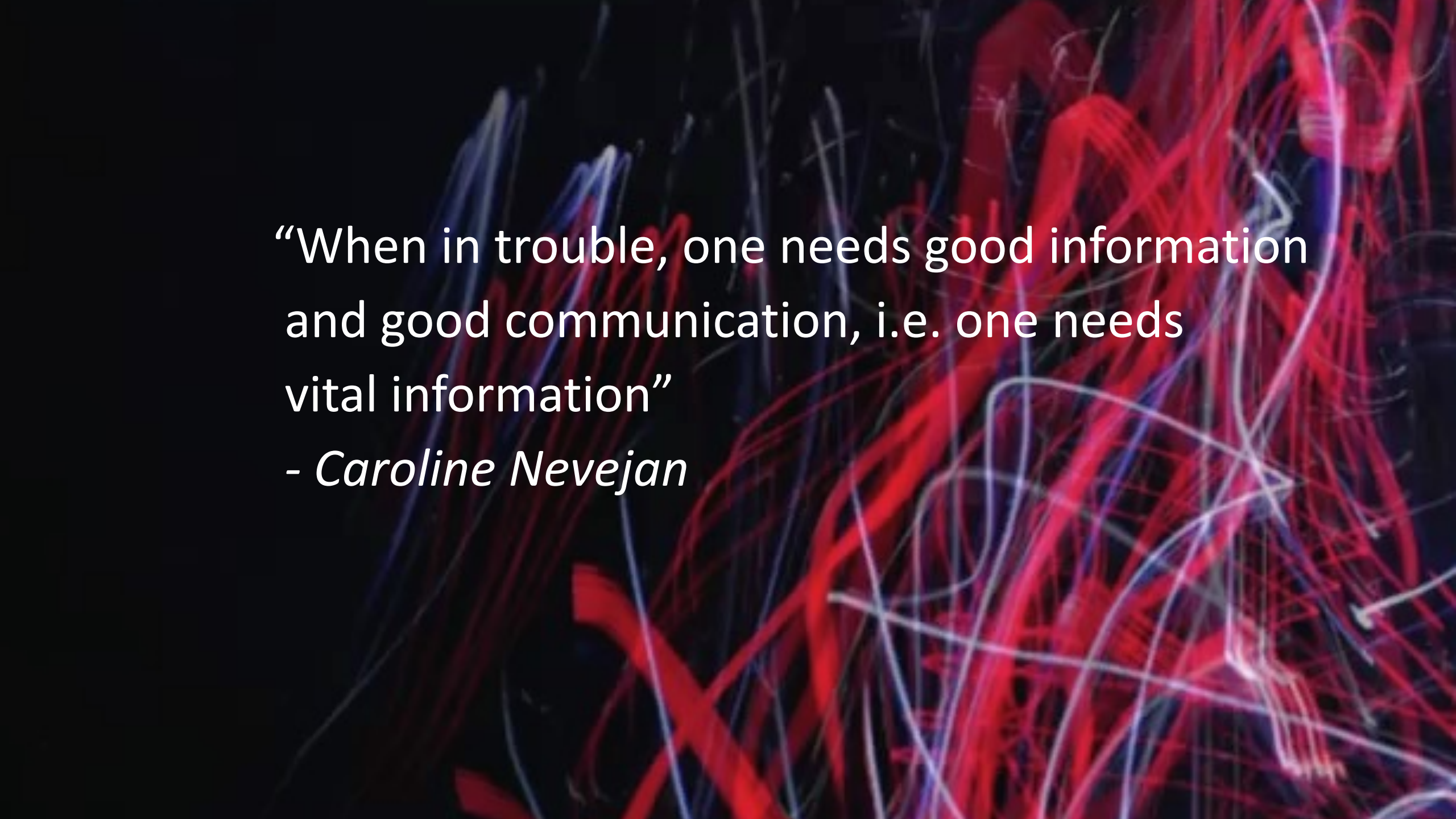
reduce jitter & packet loss to zero

repair/replace missing data and sequences and patterns

Cultural solutions:

“When mediated presence offers ‘vital information’ the bridge between natural and mediated presence becomes very smooth”

- Caroline Nevejan


“When in trouble, one needs good information and good communication, i.e. one needs vital information”
- Caroline Nevejan

Flow is both a state of being,
and a target

Summary

Communication is a driving force

Survival happens through sharing vital information & by way of cultural adaptation

The Future

Lowest-possible latencies with hardware/software improvements

No jitter, lowest possible buffers

Changes in culture, and what we consider to be a shared musical experience

Innovations in UI/UX / metaverses / collaboration engines