



What is latency: a mini- masterclass

- Rebekah Wilson

Intro: What's in this talk

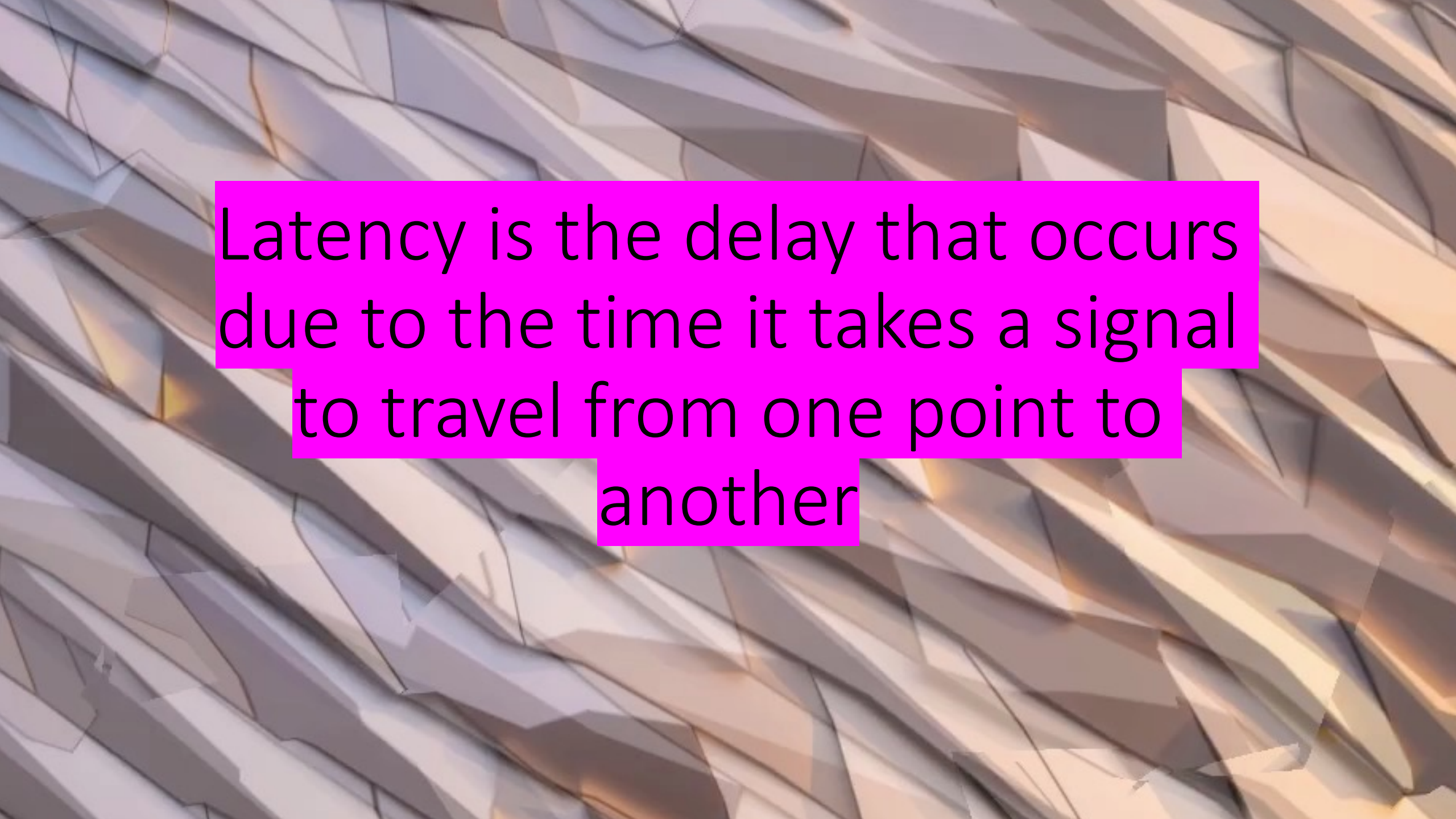
1. What is latency? A technical and historical overview
2. Latency and communications technology
3. The concept of Flow, and how it is disrupted by latency
4. Solutions and innovations to achieving flow in remote collaboration
5. The future: What innovations will come

Rebekah Wilson: Musician, composer, technologist

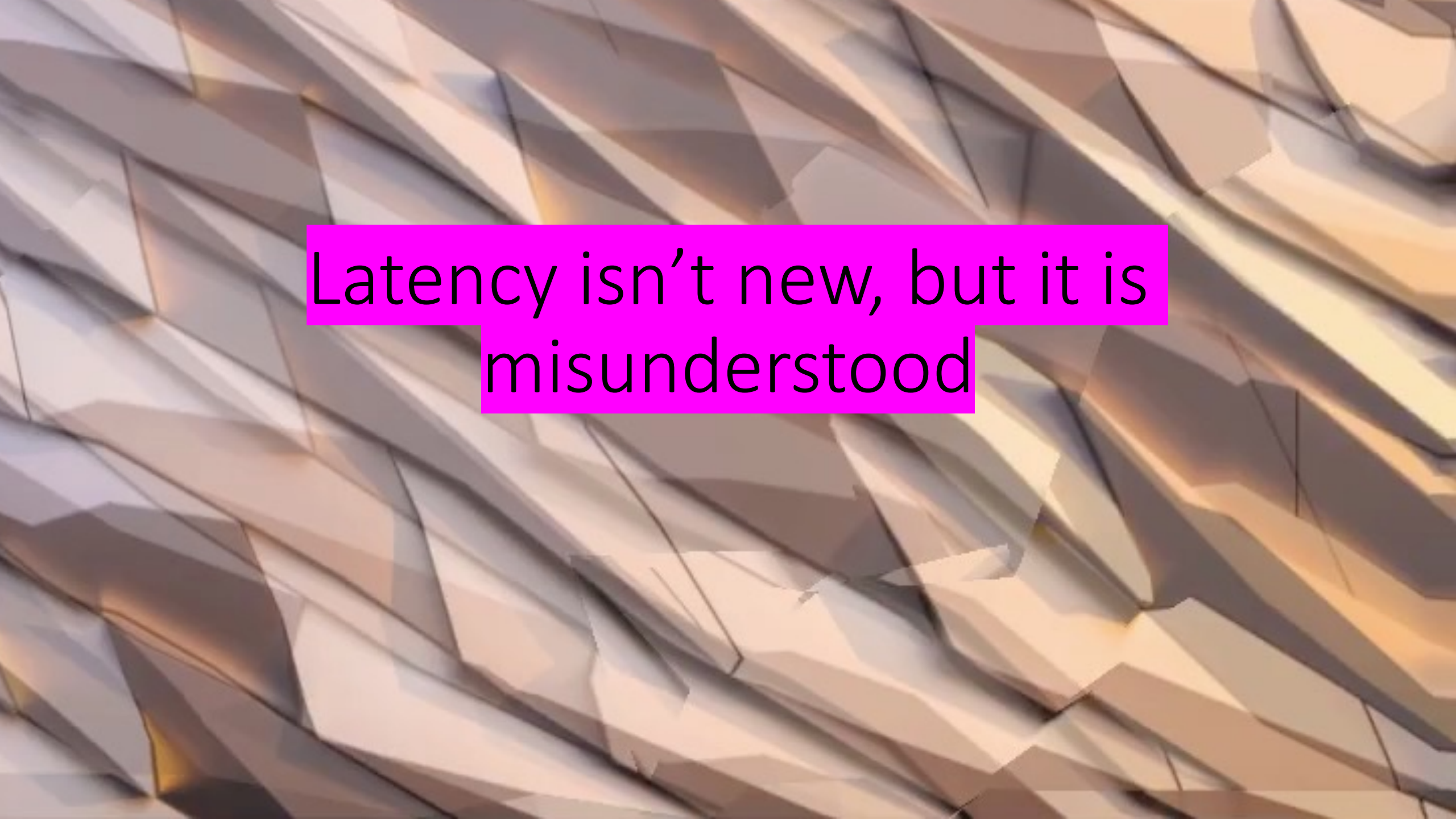
**S●URCE
ELEMENTS**

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

SUBSPACE EMISSION SCAN 247

LCARS 23295

01-23584

2054	21556930	3	25485872	2054	9584	3858	3854	3820	9245	3522	6002	21
3855	98238599	1	85244	28	741	83	38	38	859	320	388	54
6	852		285548	859	2112	110	859	8588	38	388	548	6
3823	63265498	8	52854587	32	83	388	38	7877	548	9833	6389	38
238	385885	3	204554	38	285	3858	22	38	88	21	38	6
385	54854484	5	38544548	6332	178	88	8544	689	823	6320	85	30
3821	65454878	3	38258548	1022	6990	2112	9620	3833	3202	6233	3021	9

07-3215

QUIT

09-2548

10-8215

02-24158

03-41248

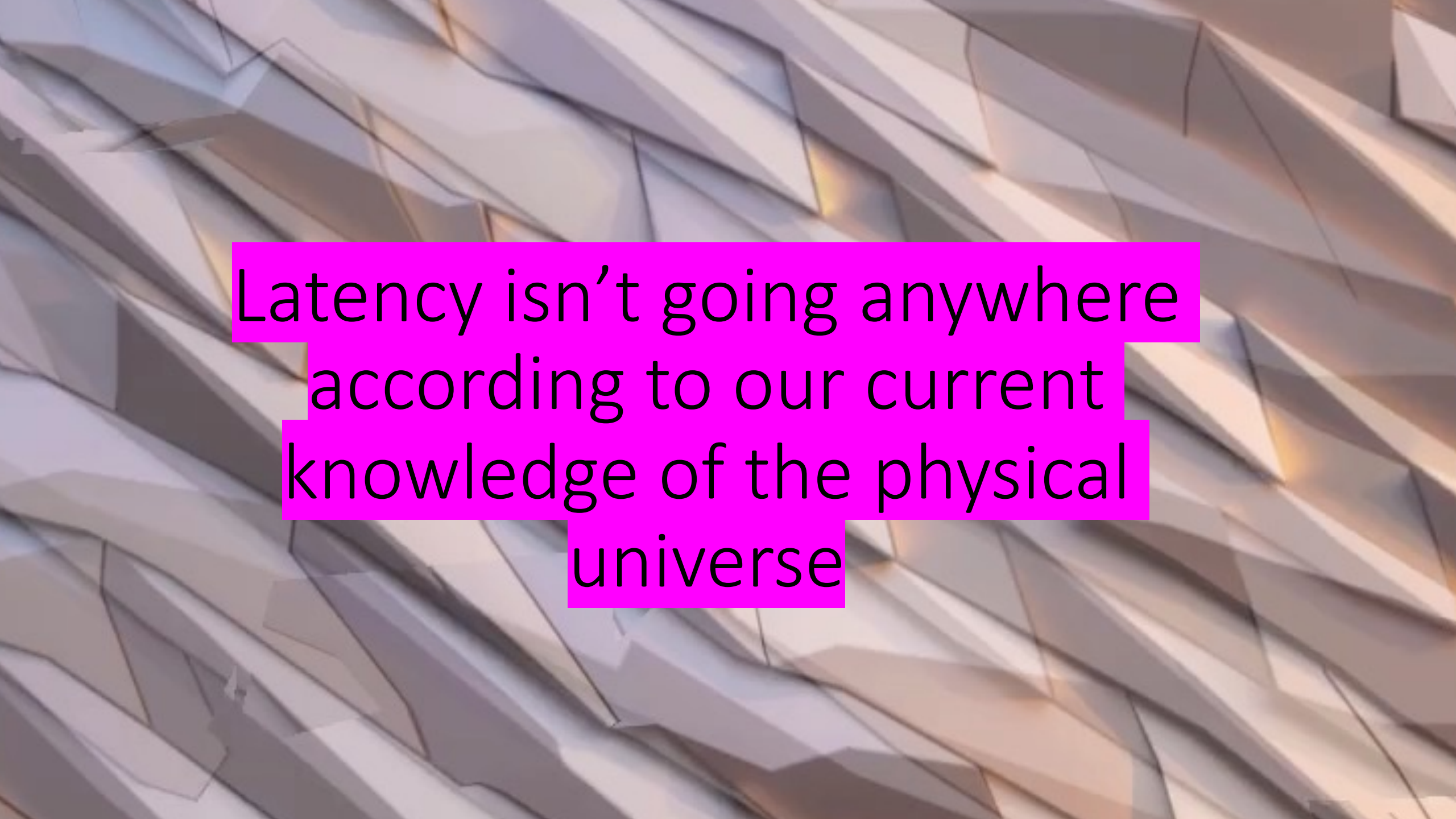
04-14702

05-32458

VERTERONS	21548	037	62871873
OMICRONS	7822	163	4565498
NUCLEONS	48875	747	74538283
CHRONITONS	38	07	382
GRAVITONS	61748	0	65464987
TETRYONS	82871	673	7822183
TACHYONS	154	6	72899747
PHOTONS	74538	288	583107
PROTONS	0157	392	5416545
ELECTRONS	77489	037	82671673
KEDION	22	3	215
DEKYONS	72899	747	5410654
BOSONS	1983	415	72899747
QUARKS	74536		107
POLARONS	0157		11454



And misrepresented
in popular culture



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

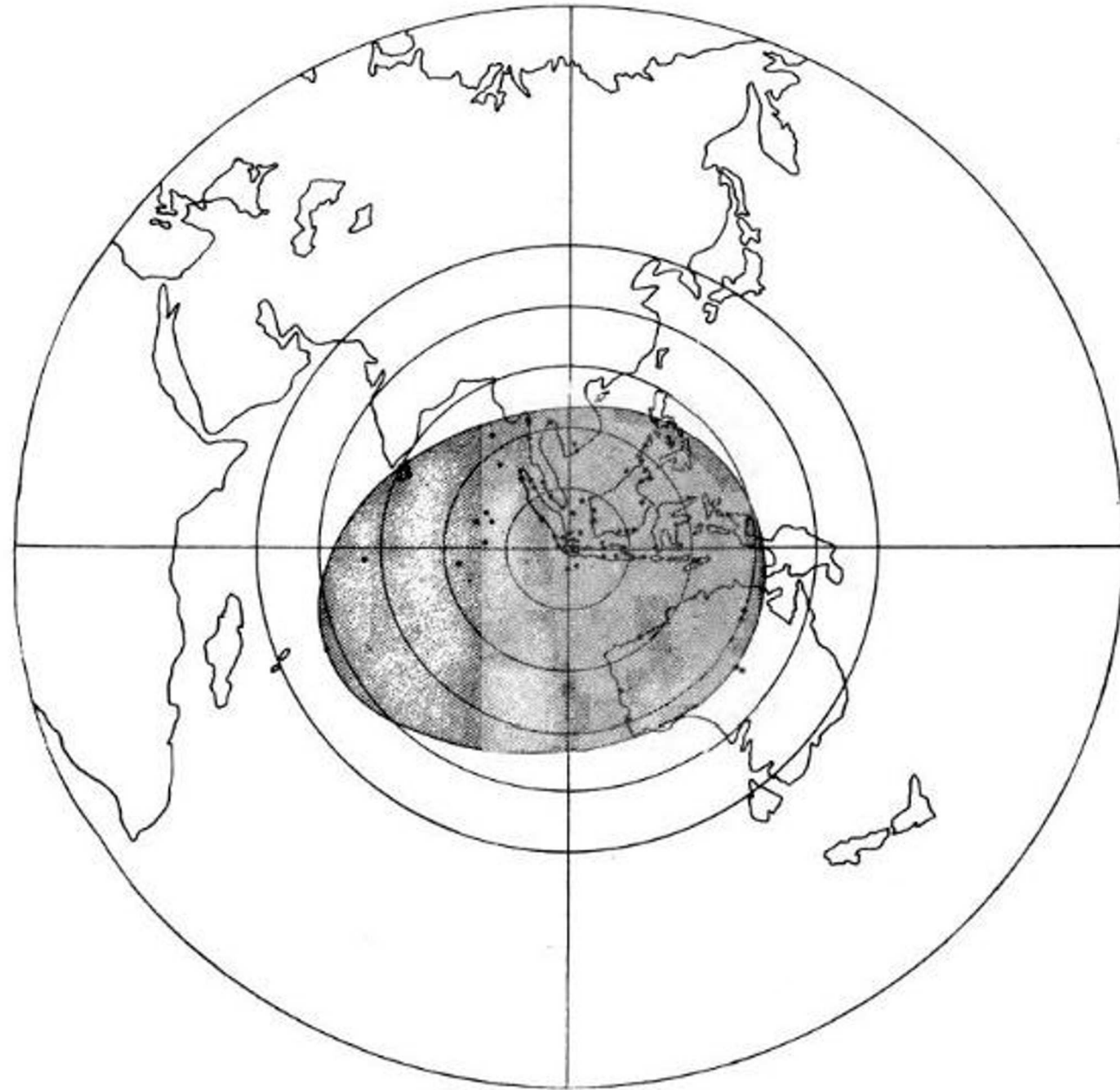
A history of latency

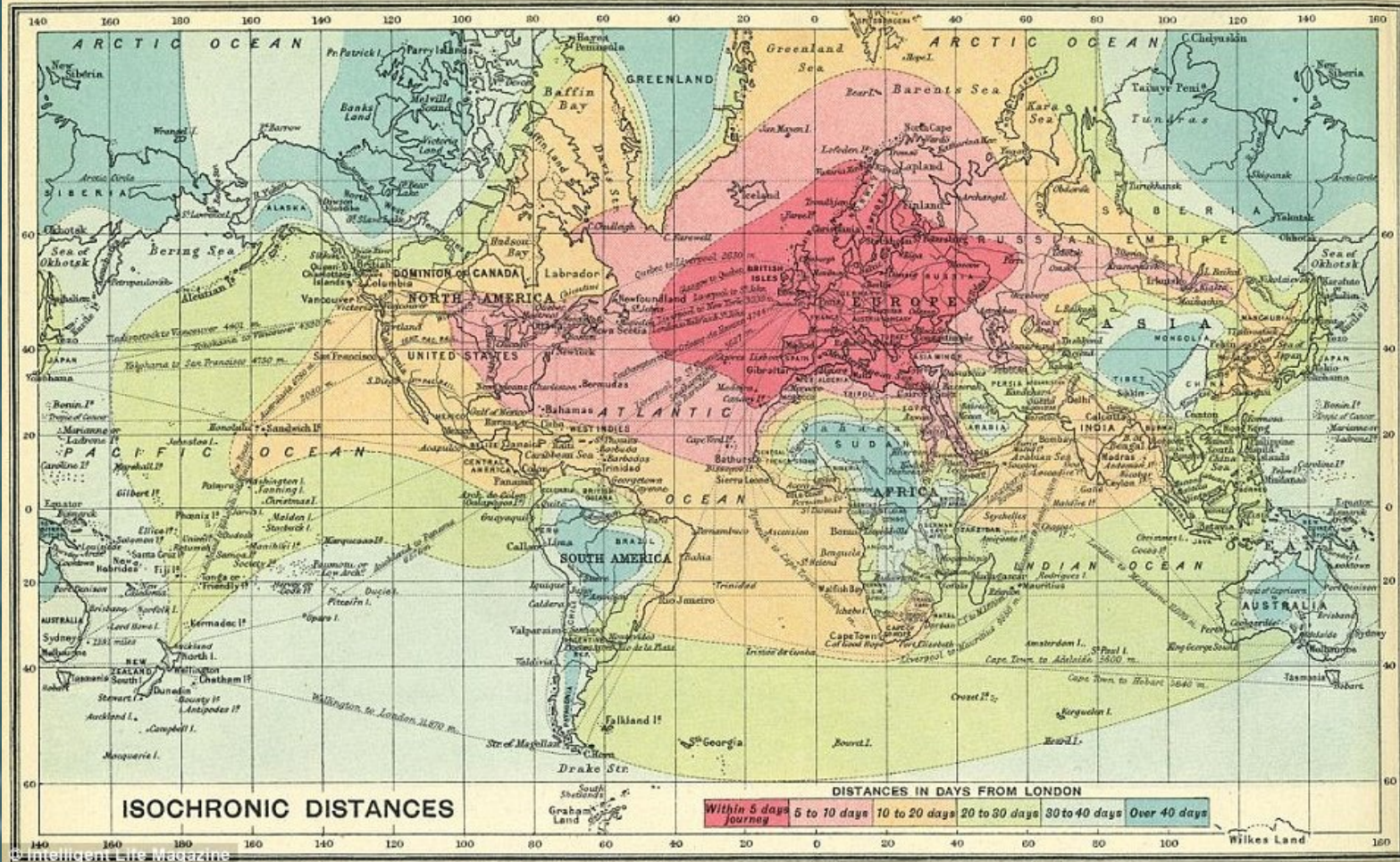
Krakatoa volcano explosion:

172 decibels heard

up to 5000 km away

– 4 hours travel time!

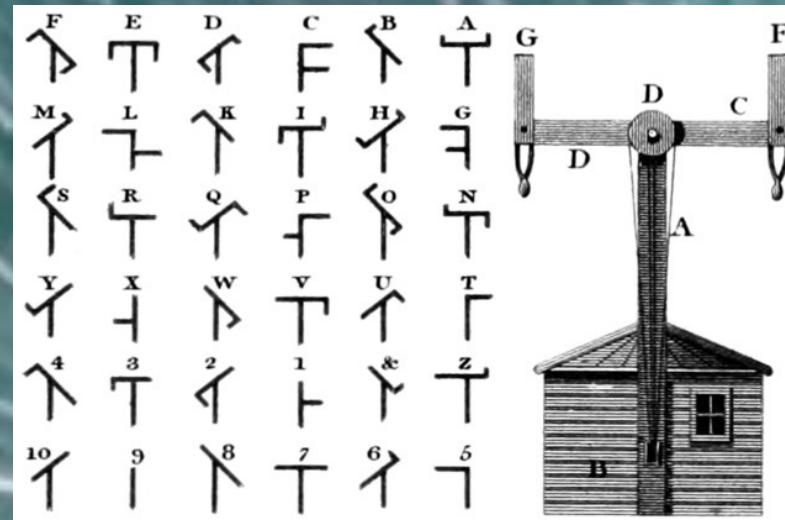




Isochronic distances have drastically shortened thanks to technology – time to send a letter a hundred years ago was measured in days and weeks, not milliseconds



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

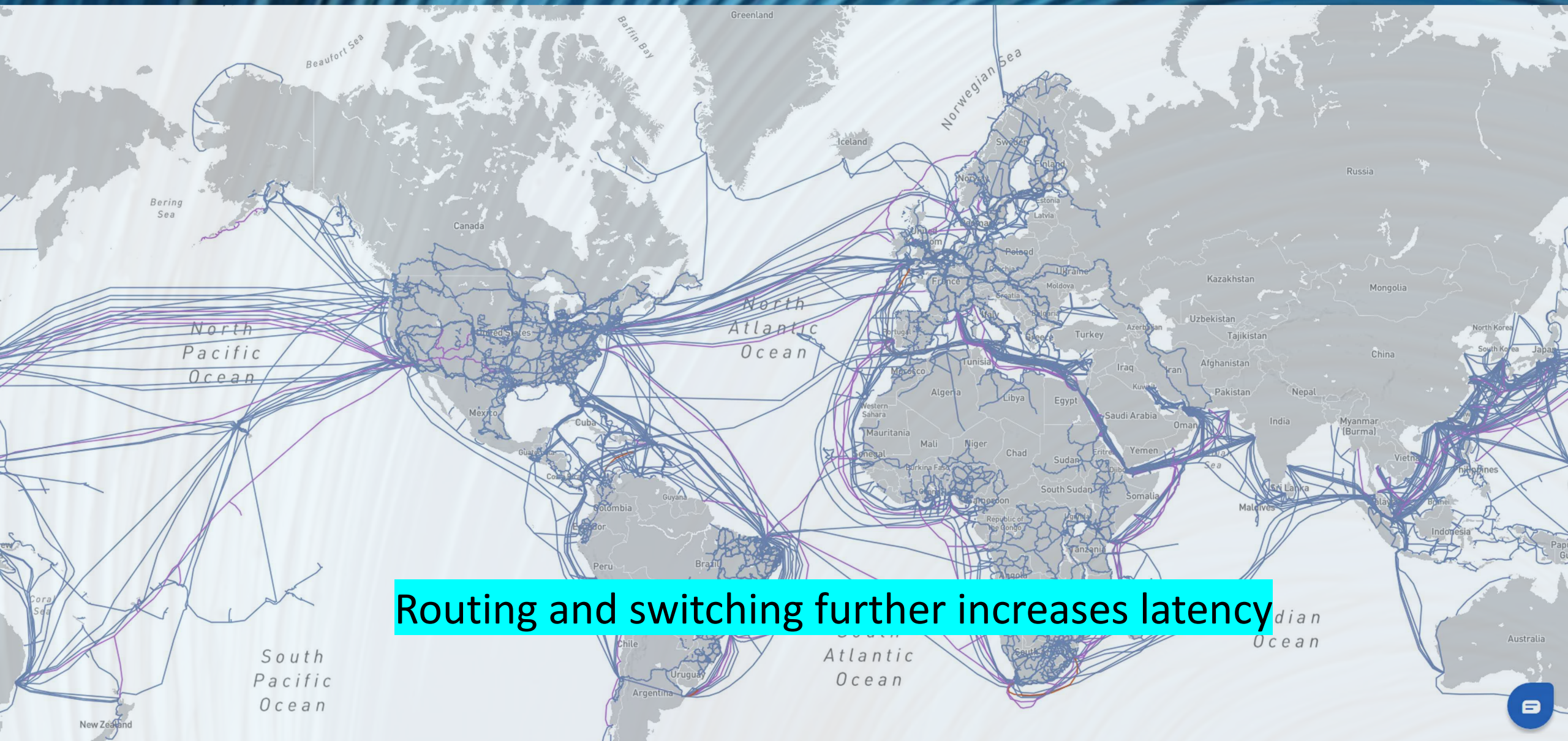
The background is a deep blue with a complex, organic pattern of fine, wavy lines that create a sense of depth and movement, resembling ripples in water or a close-up of a textured surface.

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



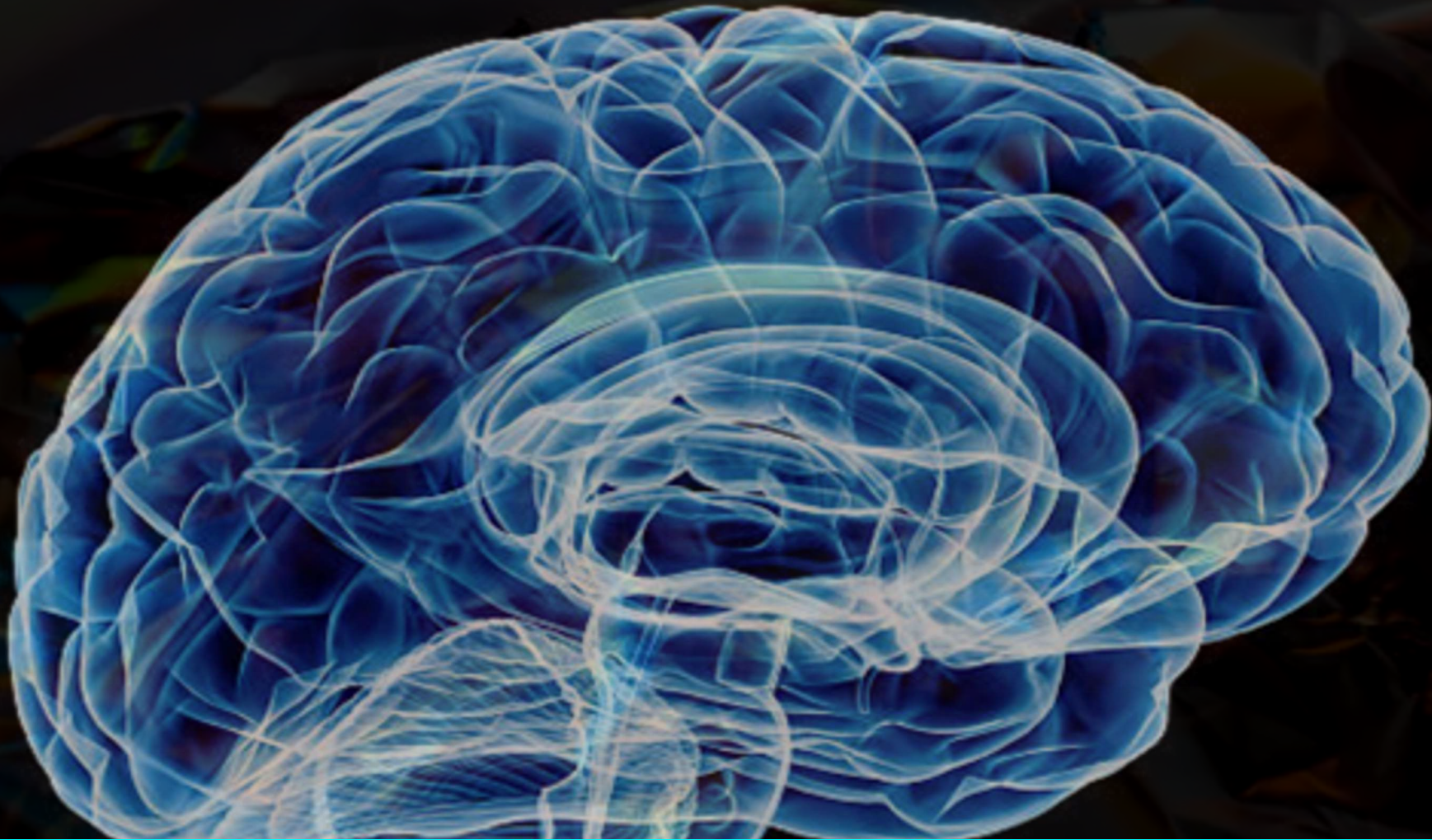
And it's not just transmission latency:

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



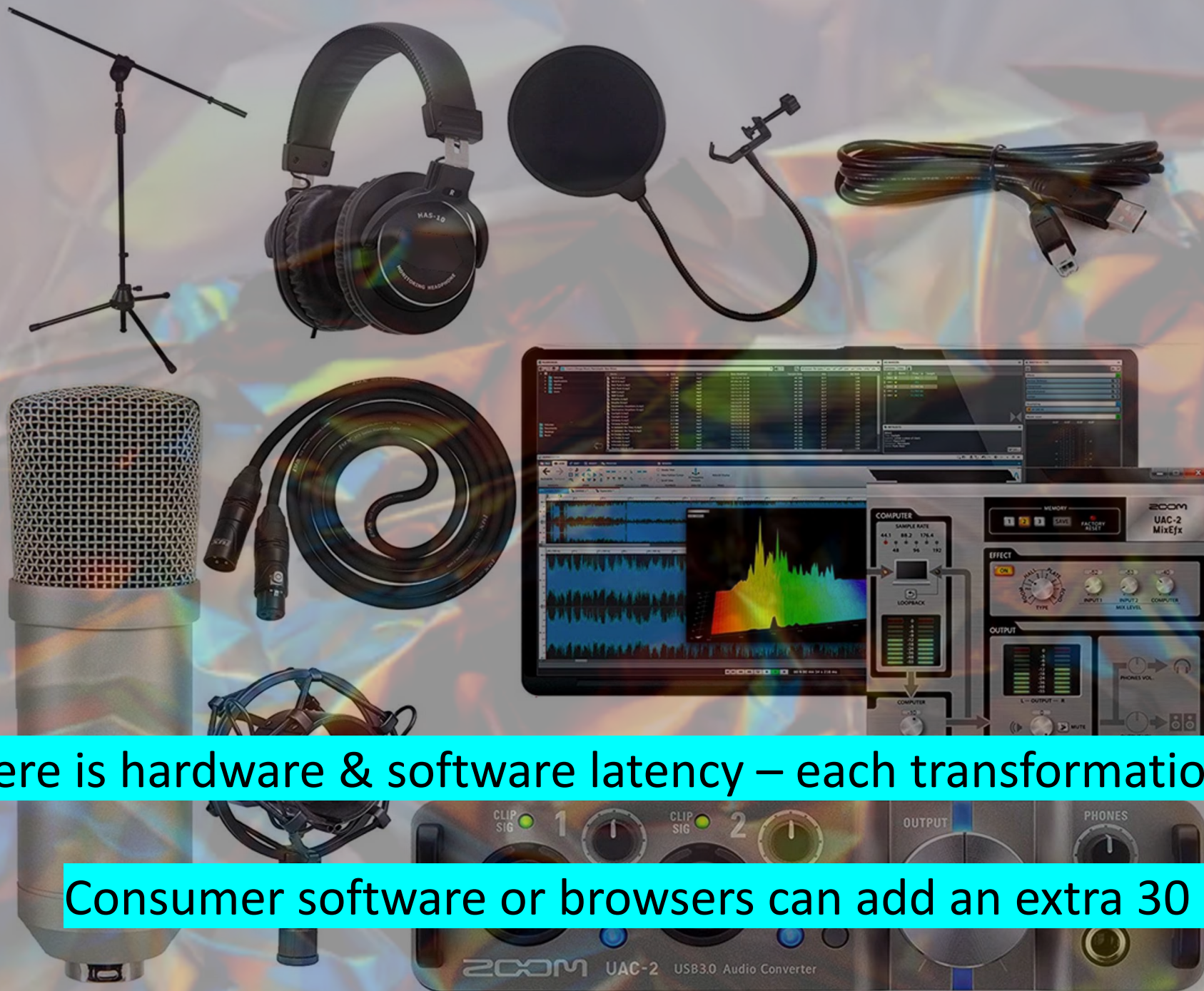
Biological latency is the time it takes for audio to be processed from physical air pressure from mechanical to electrical.

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



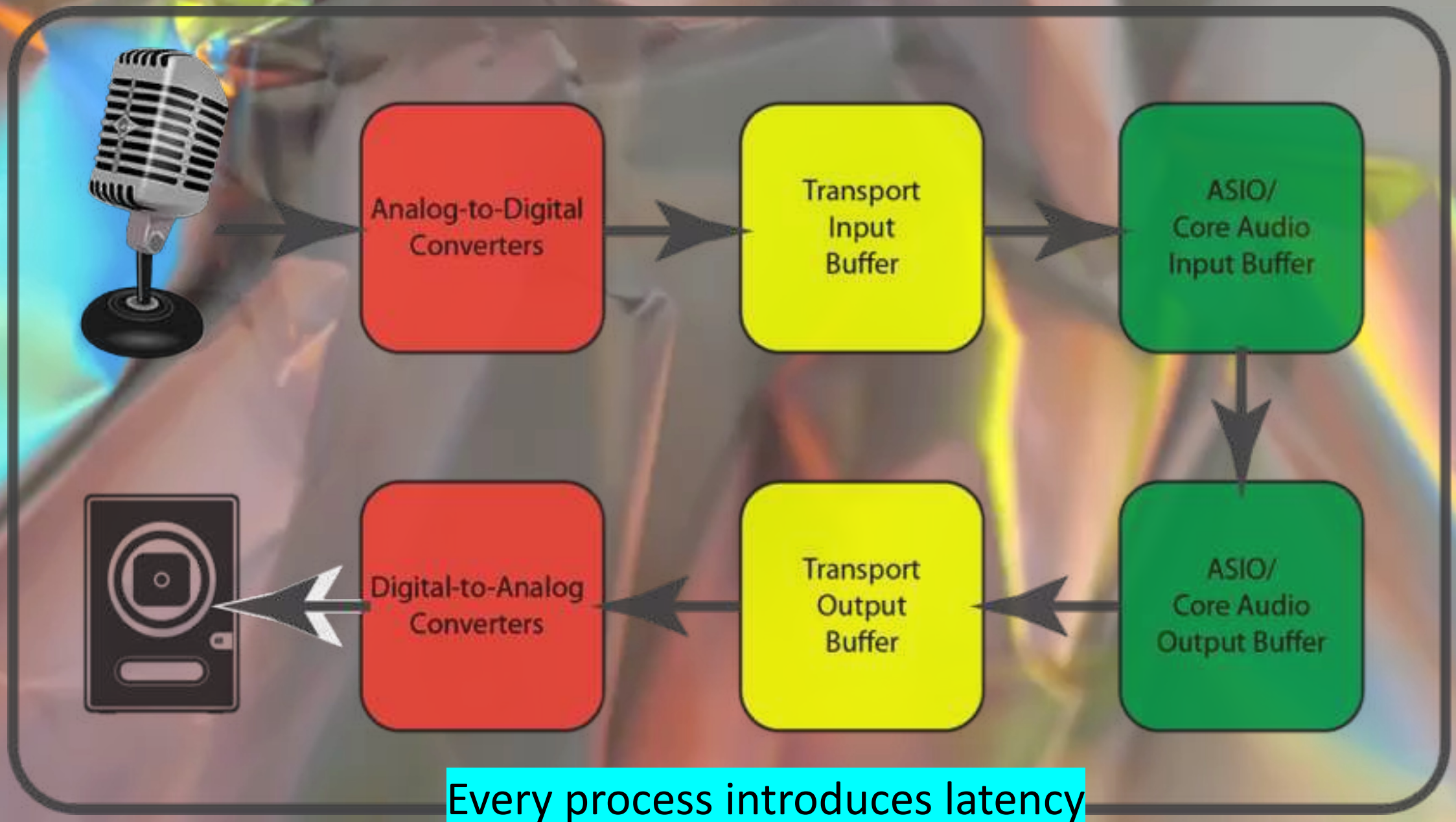
In the auditory cortex there is neurological latency, and processing speeds further depends on the brain's cognitive and emotional latency.

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!





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

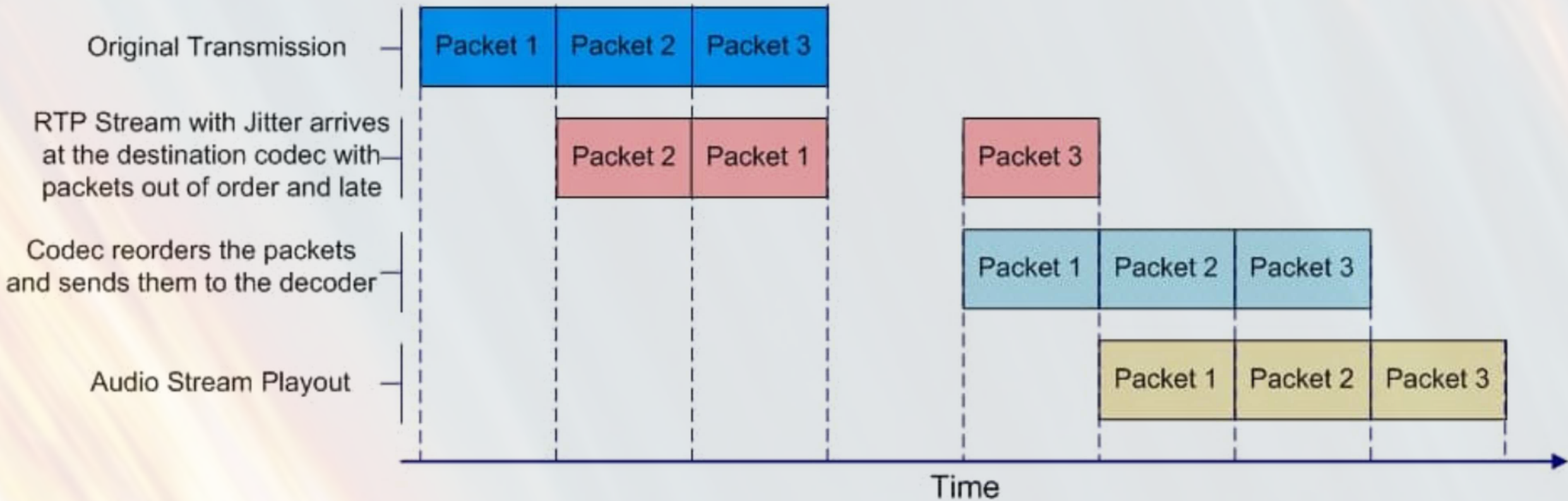
Congestion over packet networks leads to:

- 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



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

Perception:


Latency is disruptive.

You can't play music over the Internet.

But humans are clever, we adjust for disruption constantly.

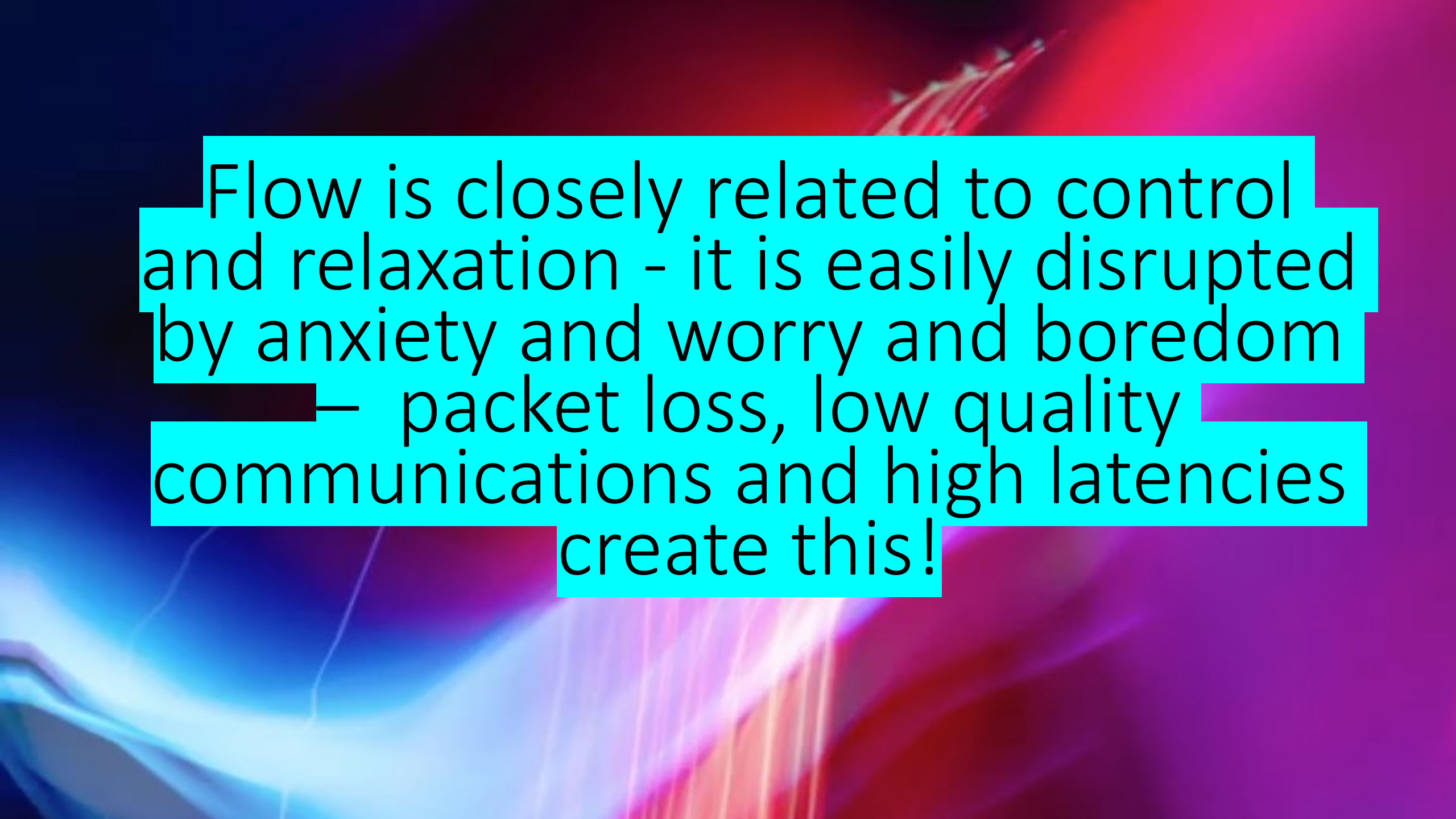
We listen to each other's rhythms and adjust constantly.

We find ways to maintain flow.



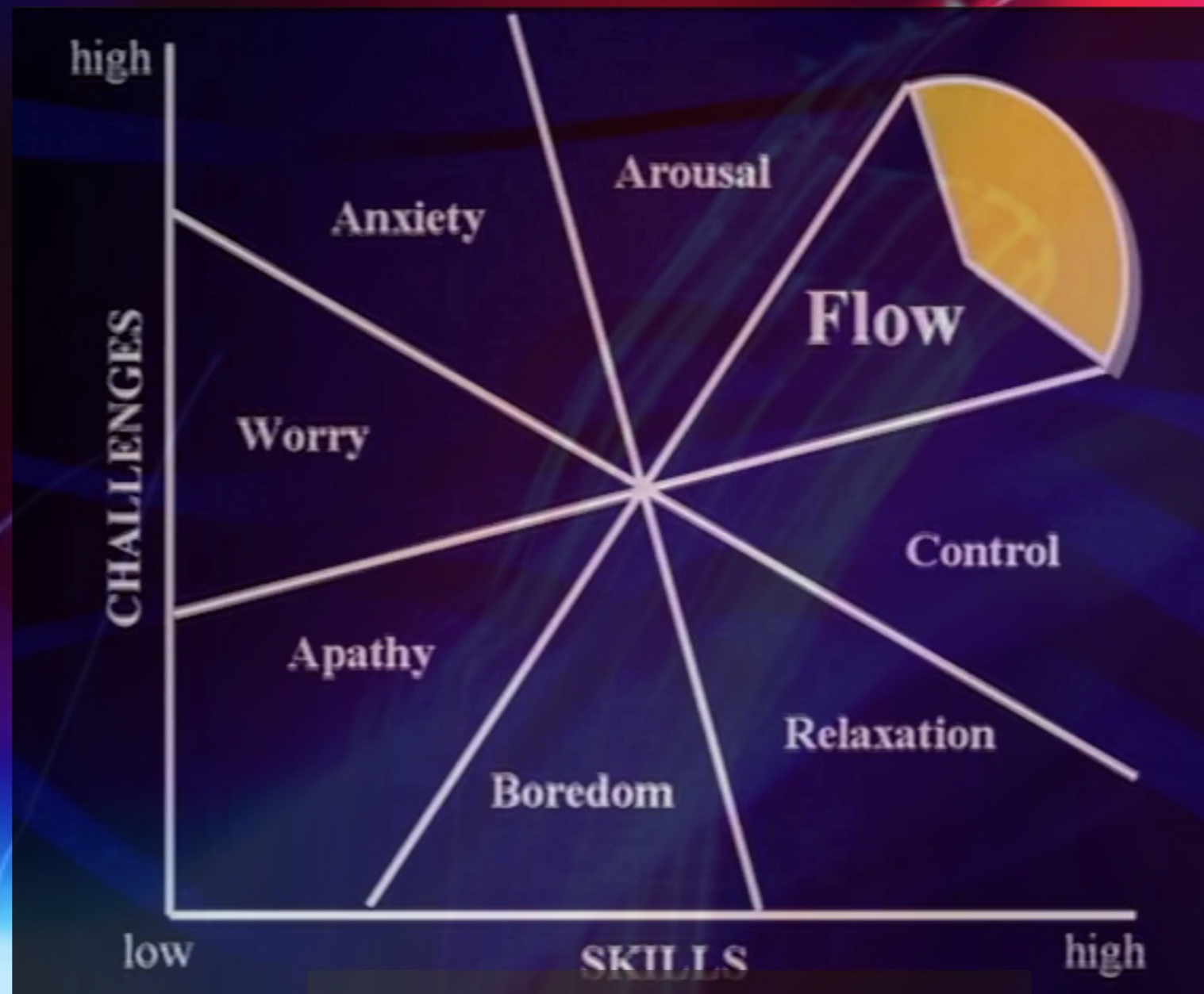
Flow is “a state in which people are so involved in an activity that nothing else seems to matter; the experience is so enjoyable that people will continue to do it even at great cost, for the sheer sake of doing it”

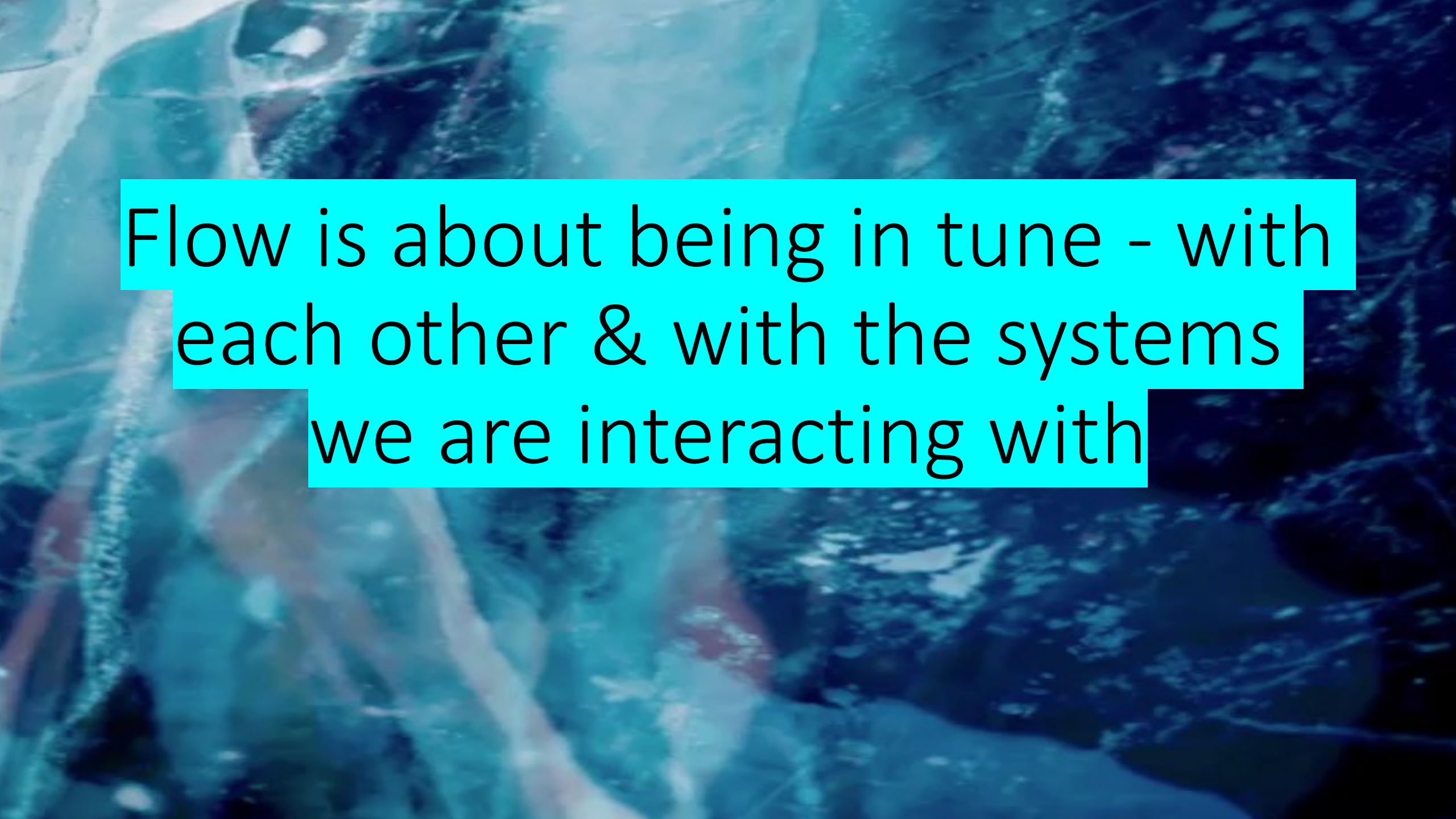
- *Mihaly Csikszentmihalyi*



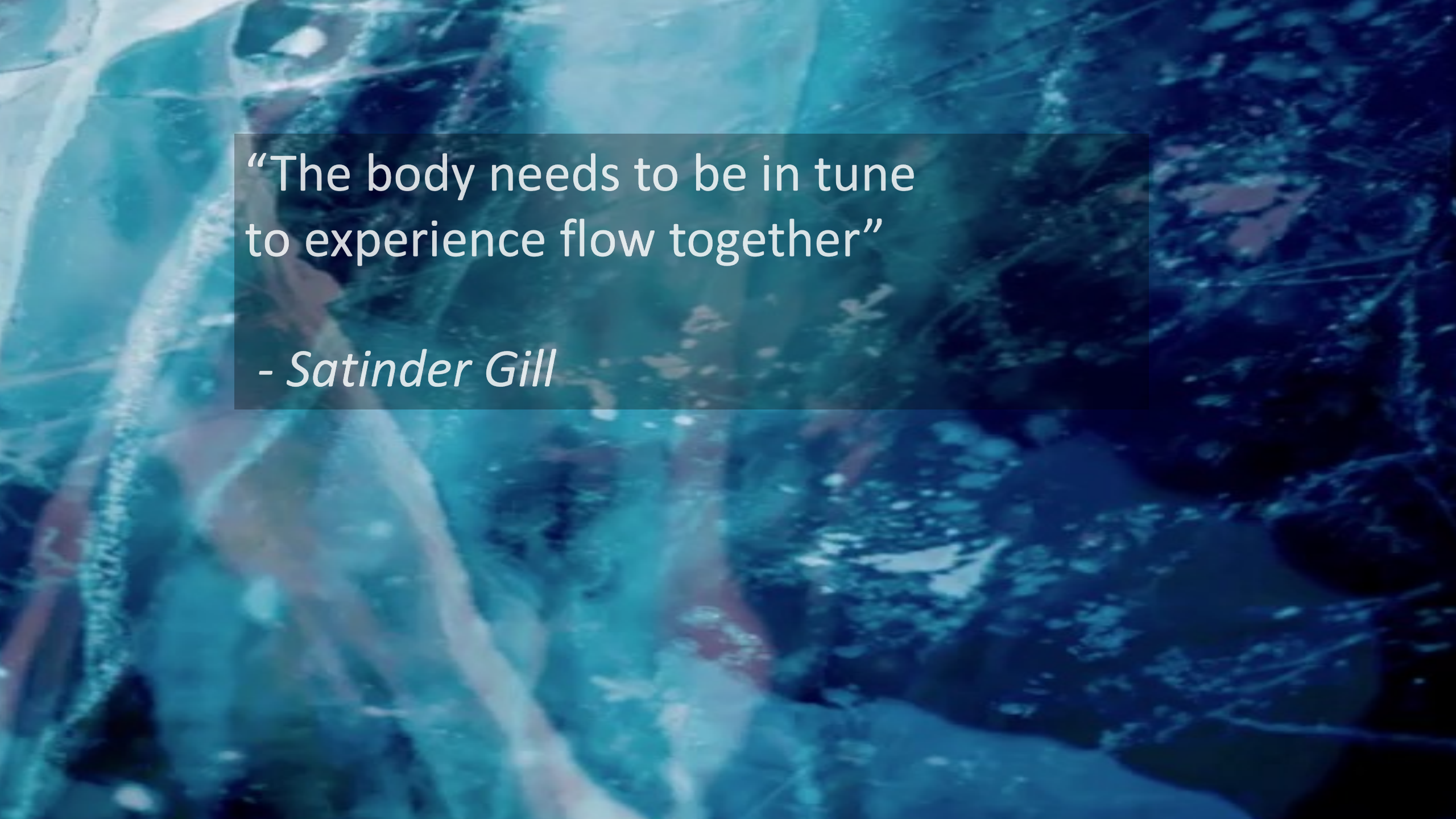
Flow is closely related to control and relaxation - it is easily disrupted by anxiety and worry and boredom

- packet loss, low quality communications and high latencies create this!



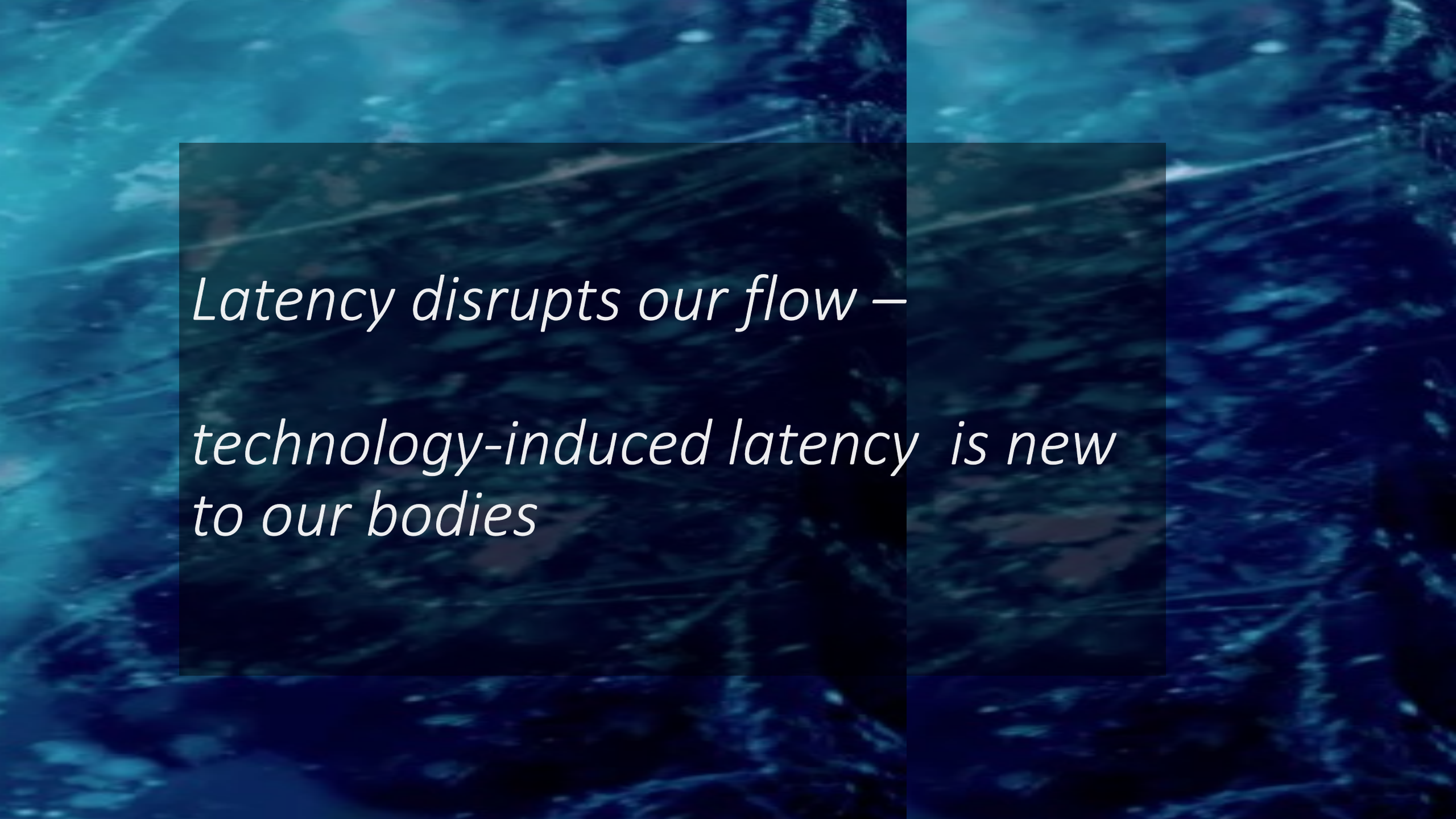
An aerial photograph of a river delta, showing a complex network of water channels and land. The image is overlaid with a semi-transparent cyan rectangle containing text.

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

An aerial photograph of a river winding through a dense forest. The water is a vibrant blue-green, contrasting with the dark, textured canopy of the trees. The river's path is clearly visible as it meanders through the landscape.

“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*

The background of the slide is a dark, textured surface with numerous thin, elongated streaks of light. These streaks are primarily in shades of purple and blue, with some hints of pink and red, creating a dynamic, almost nebula-like or particle-field effect. The streaks vary in length and orientation, giving the background a sense of movement and depth.

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

The background is a solid black field. It is decorated with numerous thin, curved, and slightly blurred lines in shades of purple and pink. These lines are scattered across the frame, with a higher concentration in the upper-left quadrant where they form a more circular, fingerprint-like pattern. The overall effect is a dynamic, abstract, and somewhat ethereal visual texture.

Adapt our performance
behaviour

The background is a solid black field. It is populated with numerous thin, elongated, and slightly curved streaks of light. These streaks are primarily in shades of pink and purple, with some appearing as a lighter magenta. They are scattered across the frame, with a higher density in the lower-left and lower-right areas, creating a sense of motion or a starry night sky.

Learn new rhythms

The background of the slide is a dark, textured surface covered with a dense, chaotic web of thin, glowing lines. These lines are primarily red and blue, with some white highlights, creating a sense of depth and complexity, similar to a network diagram or a microscopic view of a material.

We cannot realistically further
reduce latency over long distances

*low enough for traditional real-
time interactions*

The background of the slide is a dark, textured surface with a complex pattern of thin, glowing lines in shades of red and blue. These lines are scattered across the frame, creating a sense of depth and movement, similar to a network diagram or a microscopic view of a material.

Technical solutions:

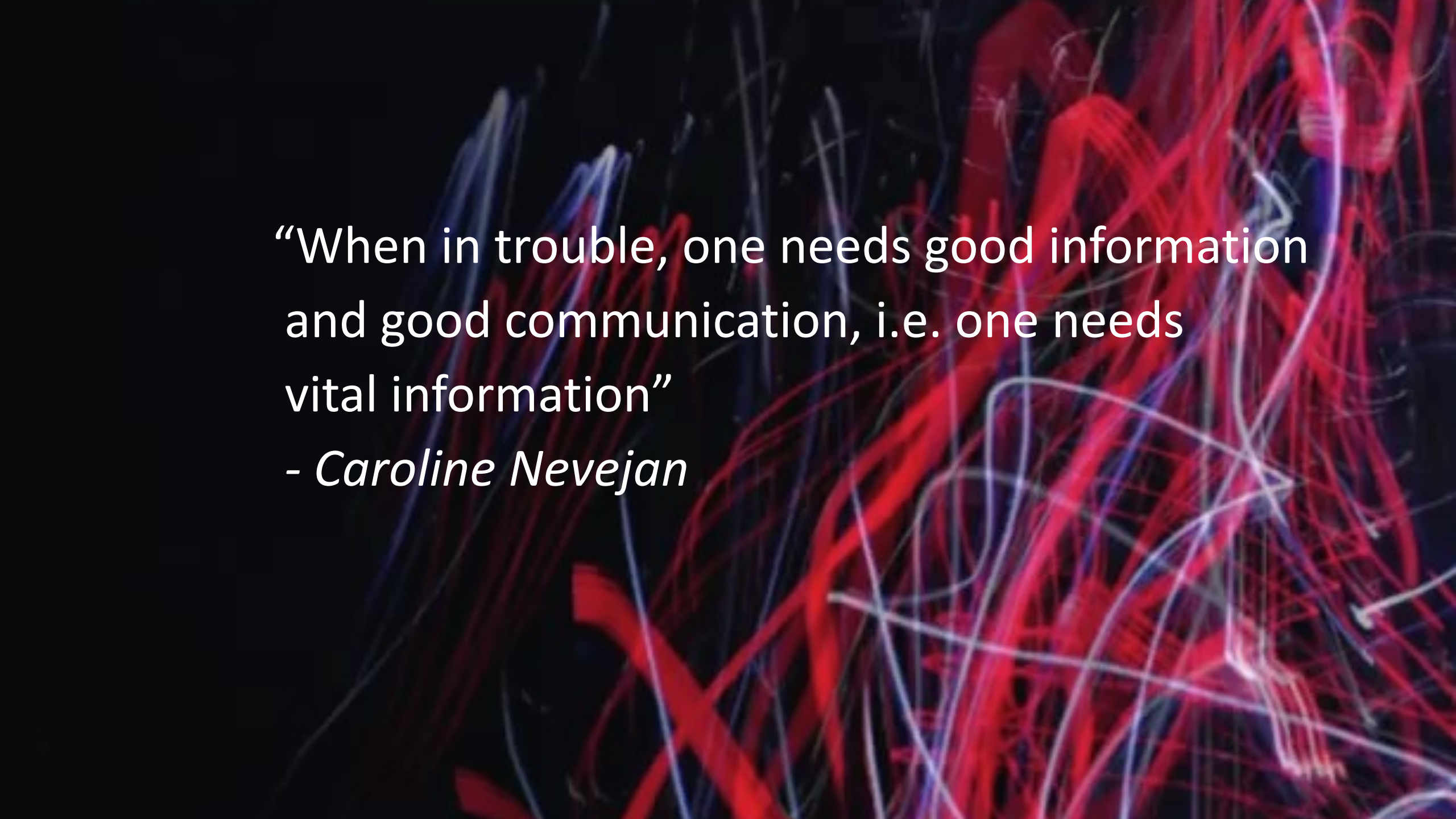
reduce jitter & packet loss to zero

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*

The background of the slide is a dark, almost black, field filled with a dense, chaotic network of thin, glowing lines. These lines are primarily red and white, with some blue and purple hues visible. They appear to be random, scribbled strokes, creating a complex, web-like pattern that suggests a tangled or intricate system. The lines vary in thickness and brightness, giving the background a dynamic, almost organic feel.

“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