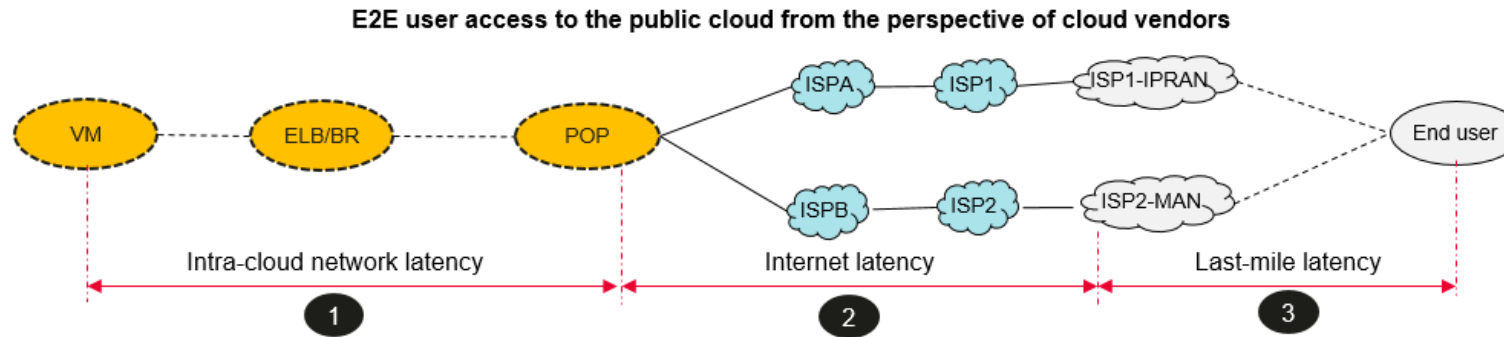


Measurement Method of Cloud network Experience Index(CEI)

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Public Network Experience Measurement Scenario



➤ Accessing Cloud Services from the Internet

There are three latency segments when users access cloud services. For cloud vendors, the latency is also divided into three segments:

- Intra-cloud network latency
- Internet latency
- Last-mile latency within the carrier network

➤ Scenario Summary:

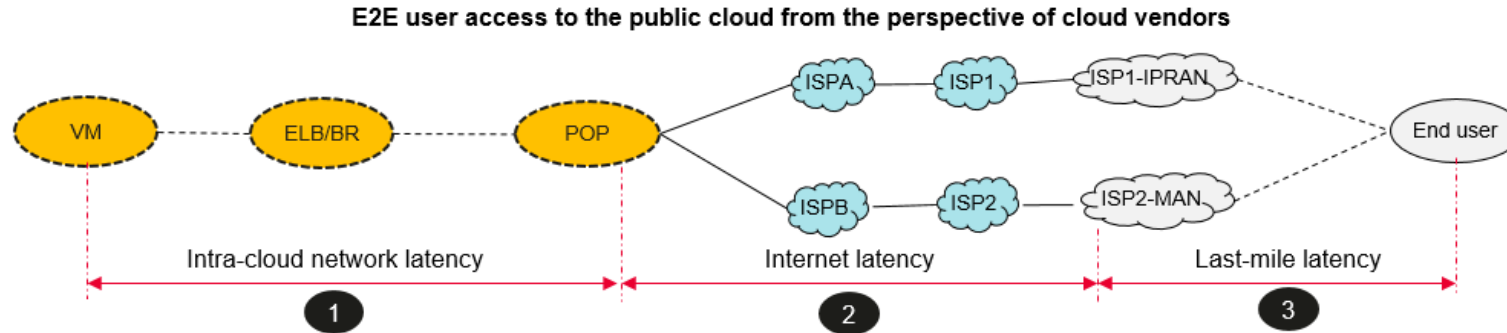
Users access the cloud applications via three network segments:

public network (1) has the widest coverage in the entire process (2) high network complexity.

==> ✘ **Quality of public network** has great impact on cloud applications.

✘ It is difficult for cloud vendors to directly access application-level Key Quality Index (KQI) data.

Cloud network Experience Index(CEI) for Evaluating Network Quality for Cloud Applications



➤ **Intuition:** deriving authentic customer experience from basic network metrics to facilitate network optimizations

➤ **Goal & Challenges:** A unified evaluating method of network experience for cloud application

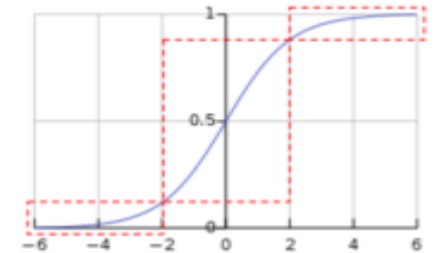
(1) **No single KPI** can provide accurate reflection of the experience for diverse services

(2) **No unified evaluation method** for experience quality

➤ **Method:** Observation & Formulation

CEI -- comprehensive **formula incorporating latency + packet-loss rate + jitter** (adopting the **S-curve** method for experience assessment – it expresses **sensitive & smooth zones** as user experience)

$$f(x) = \frac{1 + e^b}{1 + e^{a \cdot x + b}}$$



$$CEI(x, y, z) = w_{lat} \cdot \frac{1 + e^{b_{lat}}}{1 + e^{a_{lat} \cdot x + b_{lat}}} + w_{los} \cdot \frac{1 + e^{b_{los}}}{1 + e^{a_{los} \cdot y + b_{los}}} + w_{jit} \cdot \frac{1 + e^{b_{jit}}}{1 + e^{a_{jit} \cdot z + b_{jit}}}$$

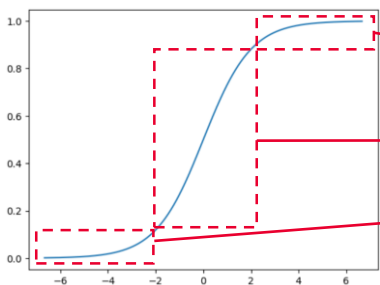
Parameter a,b: by fitting each KPI CEI curve based on a large amount of operational data

Weights: by adjusting its weight values (w1, w2, w3) according to various application categories

Formula Principle: From S-curve to User Experience

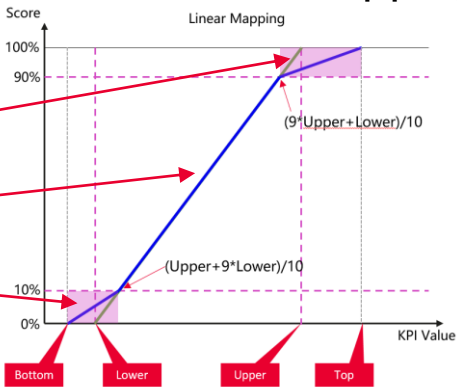
- A Classic S-curve: Sigmoid Function

$$\sigma(x) = \frac{1}{1 + e^{-x}}$$



Latency	Game Experience
<50ms	Good
50-250ms	Linear Sensitive
>250ms	Bad

Umlaut(P3) Linear Mapping

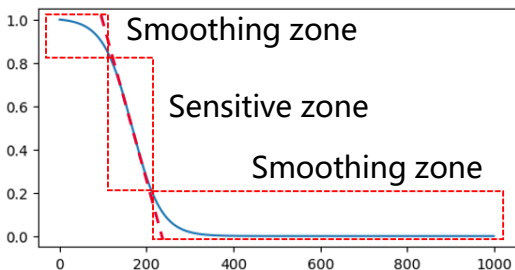


- CEI Formula:

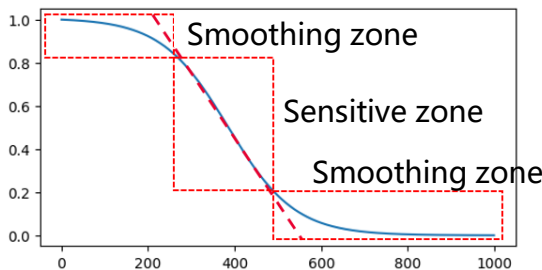
$$f(x) = \frac{1 + e^b}{1 + e^{a \cdot x + b}}$$

- a refers to the relative slope of the middle sensitive zone.

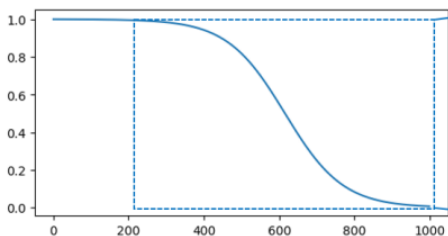
$a = 0.03$



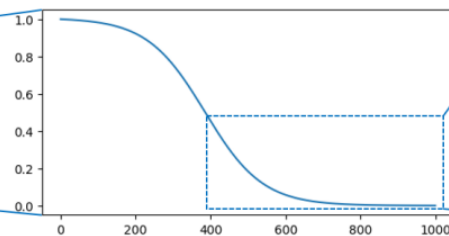
$a = 0.02$



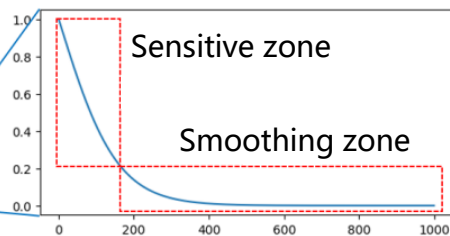
$b = -10$



$b = -5$



$b = 0$



- b refer to the hidden size of the first smoothing zone, and the top part of sensitive zone.

Cloud-Network(Customer) Experience Index: Learning

$$CEI(Latency, Loss, Jitter) = w_{lat} \cdot \frac{1 + e^{b_{lat}}}{1 + e^{a_{lat} \cdot Latency + b_{lat}}} + w_{los} \cdot \frac{1 + e^{b_{los}}}{1 + e^{a_{los} \cdot Loss + b_{los}}} + w_{jit} \cdot \frac{1 + e^{b_{jit}}}{1 + e^{a_{jit} \cdot Jitter + b_{jit}}}$$

- Pair-wise learning from user preference and expert experience
 - User preference collects the network metric and corresponding user complaints, then randomly select pairs.
 - Expert experience describes expert preference in fixed form and randomly generate data pairs.

User Preference i	User Preference j
Latency:30ms, Loss:5%, Jitter:20ms	Latency:50ms, Loss:2%, Jitter:20ms
User Complaints: 13	User Complaints: 53

Expert Experience

While loss < 5%, the smaller the latency, the better the user experience.

While latency < 30ms, the smaller the jitter, the better the user experience.

$$\max \left[\sum_{i,j \in U} \log CEI_i(\cdot, \cdot, \cdot) - \log CEI_j(\cdot, \cdot, \cdot) + \sum_{i,j \in E} \log CEI_i(\cdot, \cdot, \cdot) - \log CEI_j(\cdot, \cdot, \cdot) \right]$$

CEI Calculation Formula detail and CEI Application Scenarios

1. The calculation formula

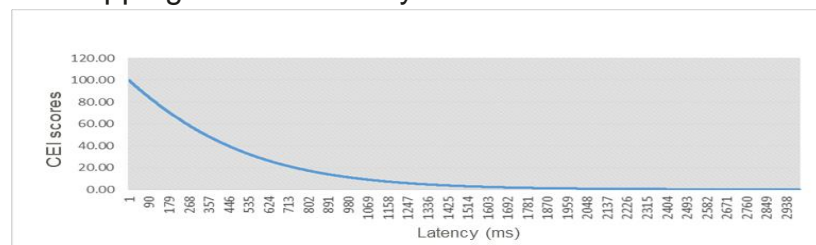
$$CEI(x, y, z) = w_{lat} \cdot \frac{1 + e^{b_{lat}}}{1 + e^{a_{lat} \cdot x + b_{lat}}} + w_{los} \cdot \frac{1 + e^{b_{los}}}{1 + e^{a_{los} \cdot y + b_{los}}} + w_{jit} \cdot \frac{1 + e^{b_{jit}}}{1 + e^{a_{jit} \cdot z + b_{jit}}}$$

2. Metric description

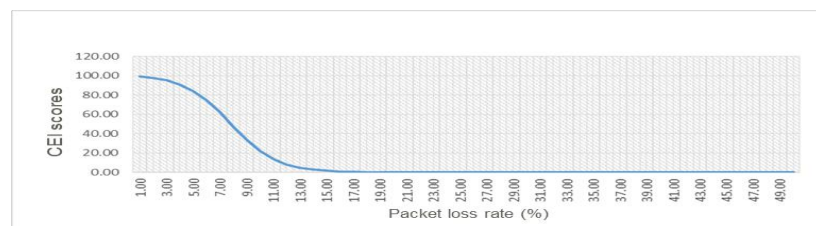
Metric	Weight (Delay-Sensitive)	Parameter a	Parameter b
Latency	70	0.00254	0.926
Packet loss rate	20	0.577	-4.5
Jitter	10	0.0745	-0.814

3. Mapping between metrics and CEI scores

✓ Mapping curve of latency and CEI scores



✓ Mapping curve of packet loss rate and CEI scores



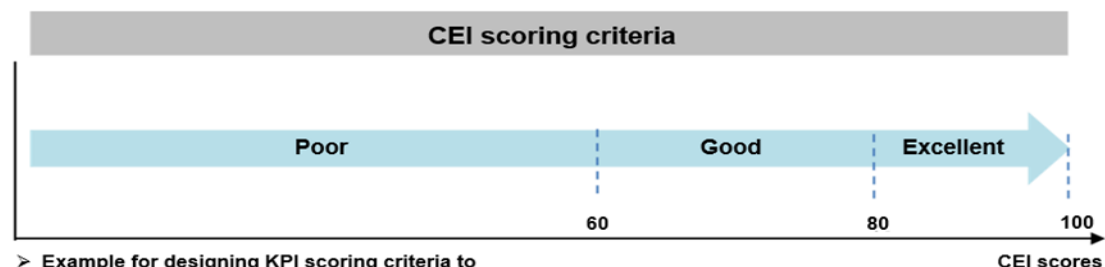
4. CEI Application Scenarios

1) Single-carrier scenario: Measure the performance of the network from a single carrier to a cloud vendor using CEI.

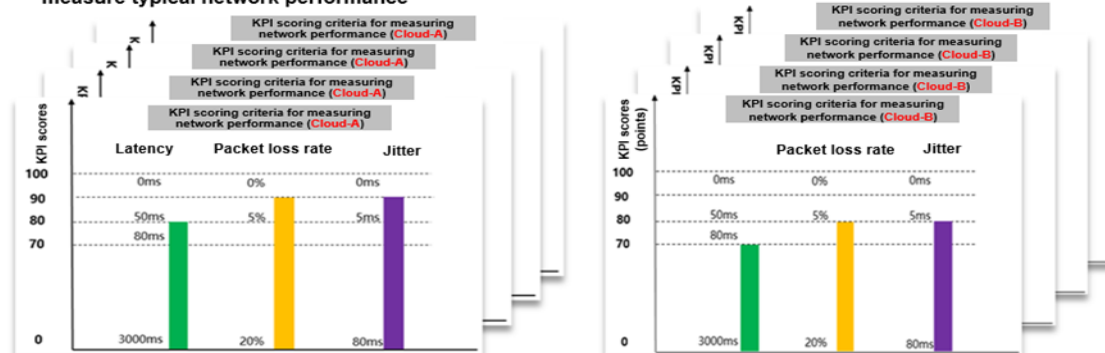
- ✓ Excellent: 80+
- ✓ Good: 60–80
- ✓ Poor: 0–60

2) Multiple-carrier scenario: Measure the performance of the network from multiple carriers to a cloud vendor using CEI.

- ✓ Excellent: 80+ (average)
- ✓ Good: 60–80 (average)
- ✓ Poor: 0–60 (average)



➤ Example for designing KPI scoring criteria to measure typical network performance



Thank you.

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每个组织，构建万物互联的智能世界。

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