



# Towards a Predictive Internet

01-NOV-2021

**JP Vasseur - Cisco Systems**



# Imagine a world (only) reacting with no learning?



## Networking ...

**Network recovery has been reactive for 25 years...**

- Protection/Restoration
- Relies on fast detection of failure, followed by rerouting
- Fast OSPF, IS-IS, BGP-PIC, MPLS FRR, IP FRR, multi-layer recovery, ...

**Still no learning ...**



## The Human Brain ...

- Learning thanks to experience
- Role of memory in anticipation in PreFrontal Cortex (PFC)
- Planning is about Forecasting ...



## The Networking Brain

**Learning ... capable of:**

- Direct application feed-back (yes)
- Build a model of (Internet) world (network & application)
- Predict a (with some error) & Automate
- Constantly adapts via learning ...

# Objectives of a Predictive Internet



The Predictive Internet is about:

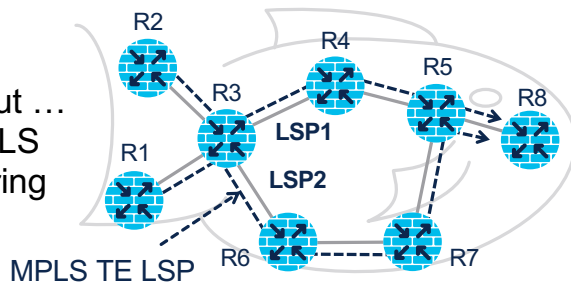
Use of **Predictive** approach  
(combined with Reactive)

**Application Experience**  
(Dark & Grey Failures)

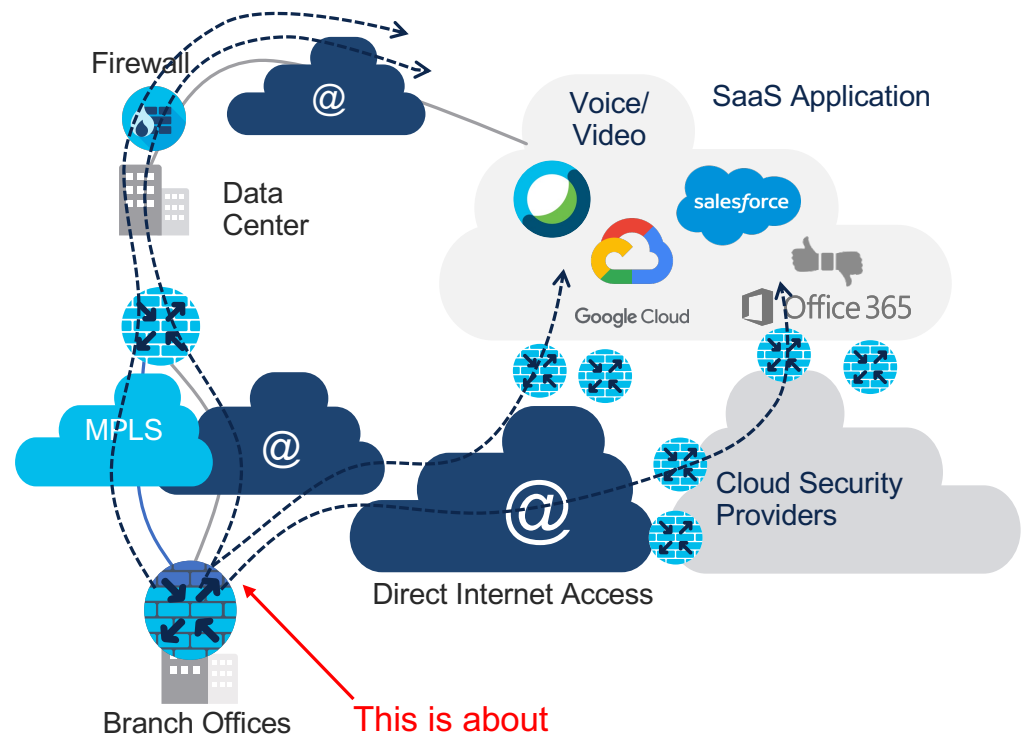
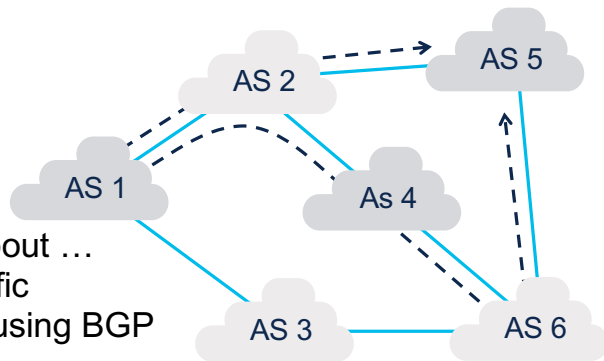
**(Trusted) Automation**  
(Self Healing networks)

# A Predictive Internet with Edge Control point

This is not about ...  
Intra AS IP/MPLS  
traffic Engineering

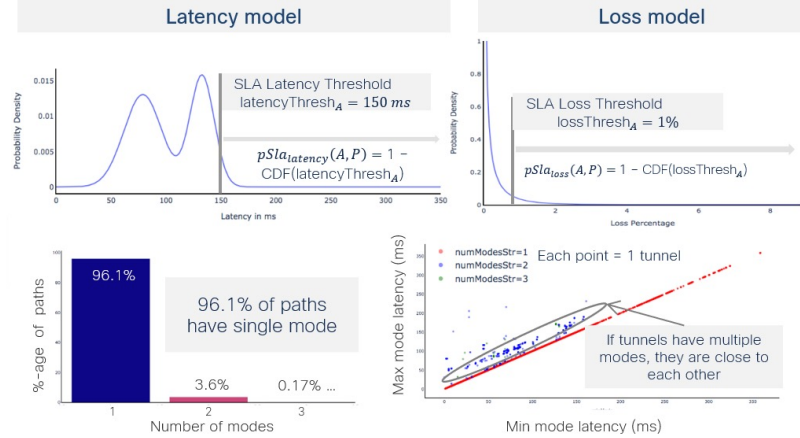


This is not about ...  
Inter-AS Traffic  
Engineering using BGP



This is about  
**Edge Predictive Path Selection**

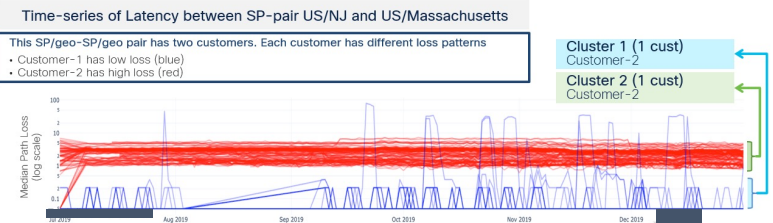
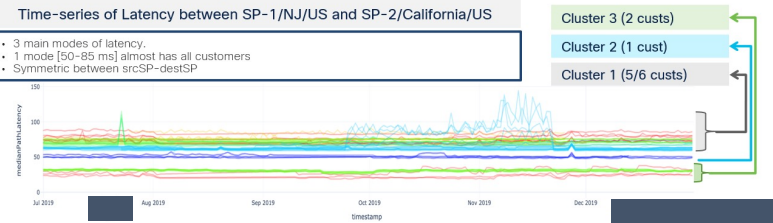
## Latency / Loss Statistical Models



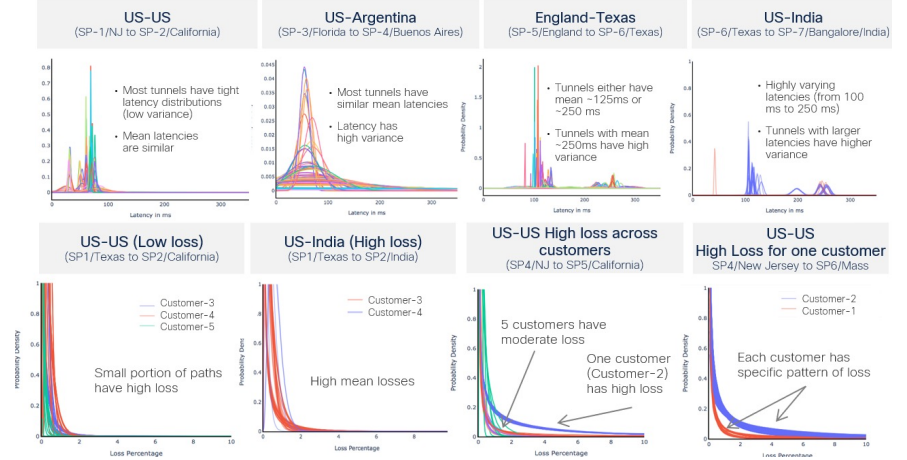
## Seasonal Peak Time of Day



## Dynamics of Latency

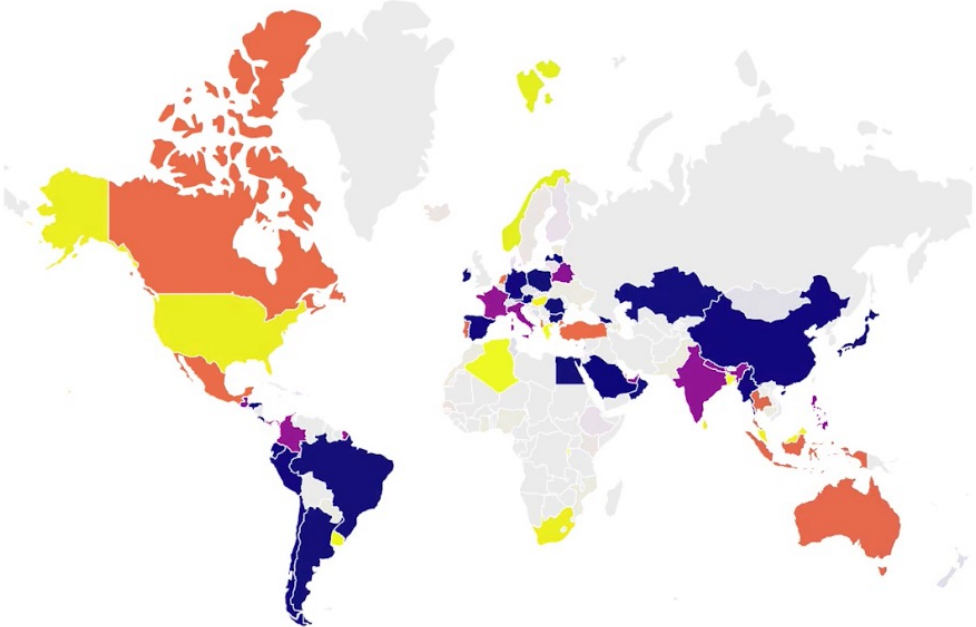
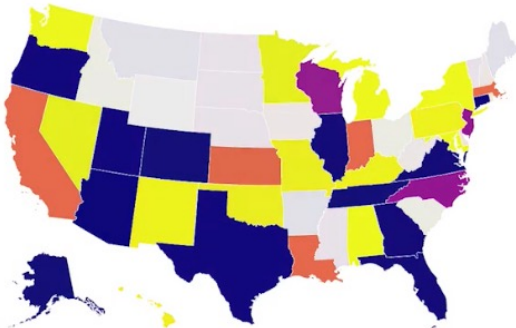


## Dynamics of Latency and Loss



# Voice Quality (User Experience Score) Variability

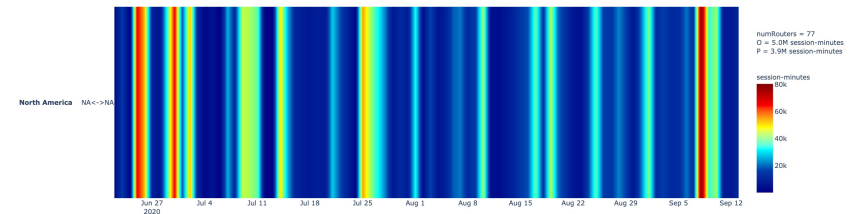
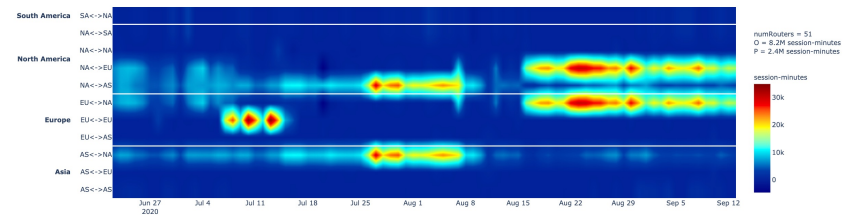
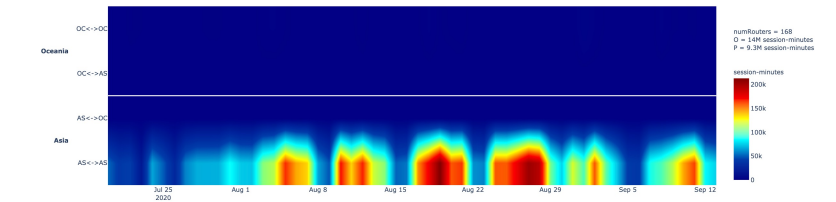
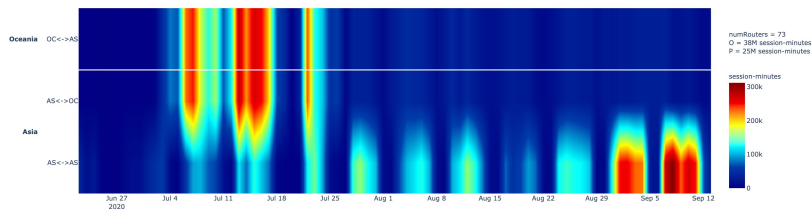
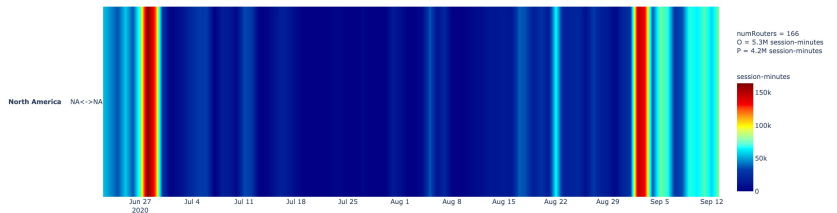
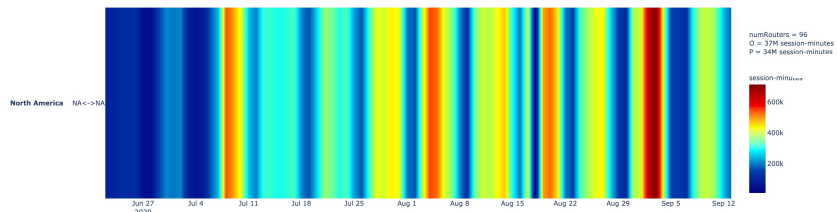
Sat 19 Dec 2020



Percentage of Reports where **UES < 4**

- 0 to 10%
- 10% to 19%
- 20%
- 20% to 100%

# Results

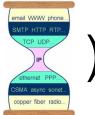


Networks all have very different patterns ...  
highlighting the importance of Learning ...

# Conclusion

## Enabling Learning in the Internet is overdue (Predict)

Need to extend the notion of Dark failure (lack of connectivity) to Grey failure with application impact

The Internet stack concept of layering (IP hourglass model ) did allow for scaling. With an application centric view, cross-layer signaling is useful

More results, white papers in-progress ...





# Thank you

01-NOV-2021

