

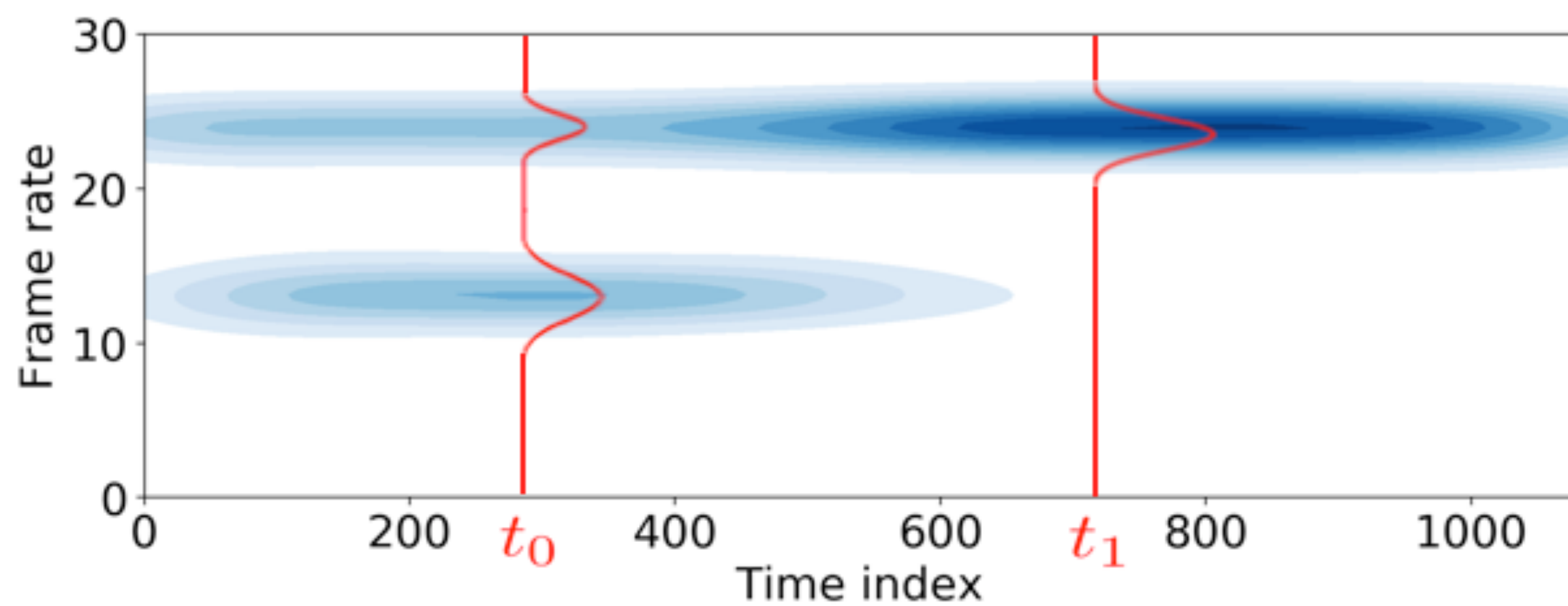
Predicting Distributions of Service Metrics with Neural Networks

KTH, RISE, and Ericsson Research

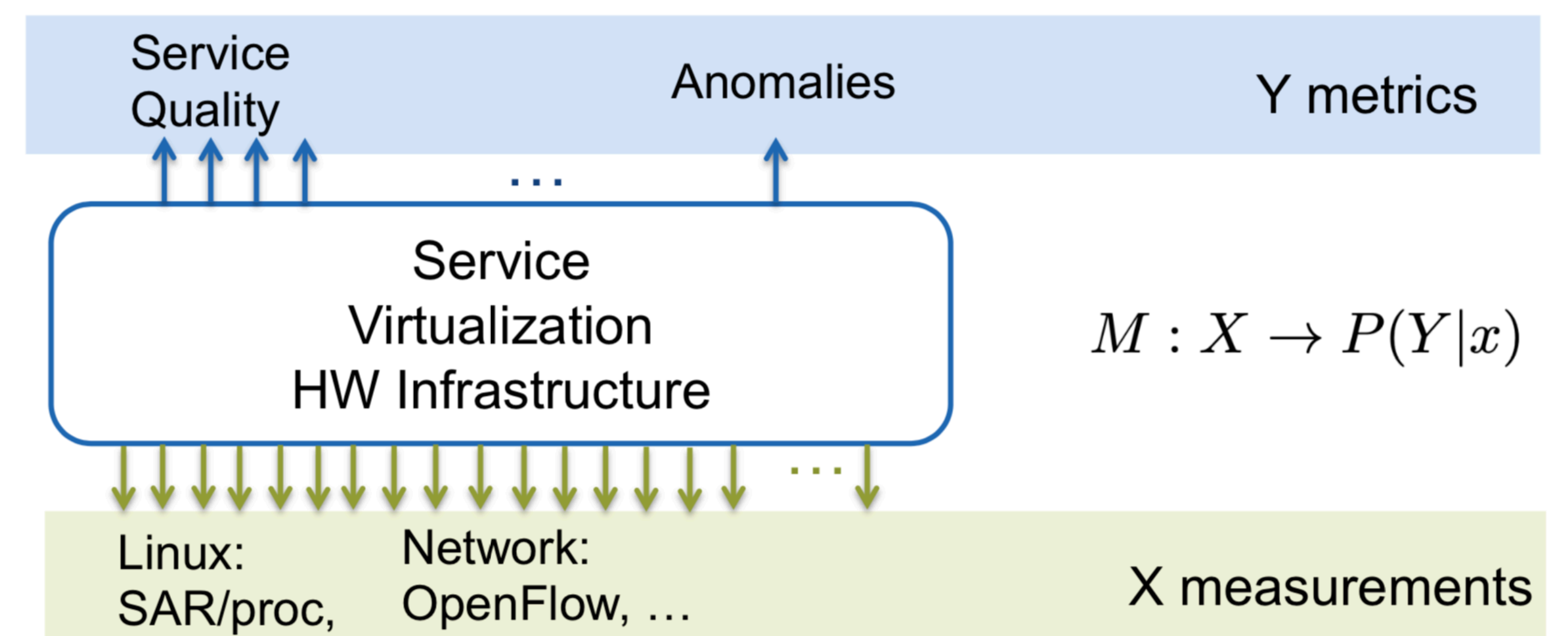
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Motivation

- We predict service and other system metrics as conditional distributions.
- **Conditional distributions** capture the behavior of systems in detail.
- **Gaussian mixture models and MDNs** produce accurate predictions.



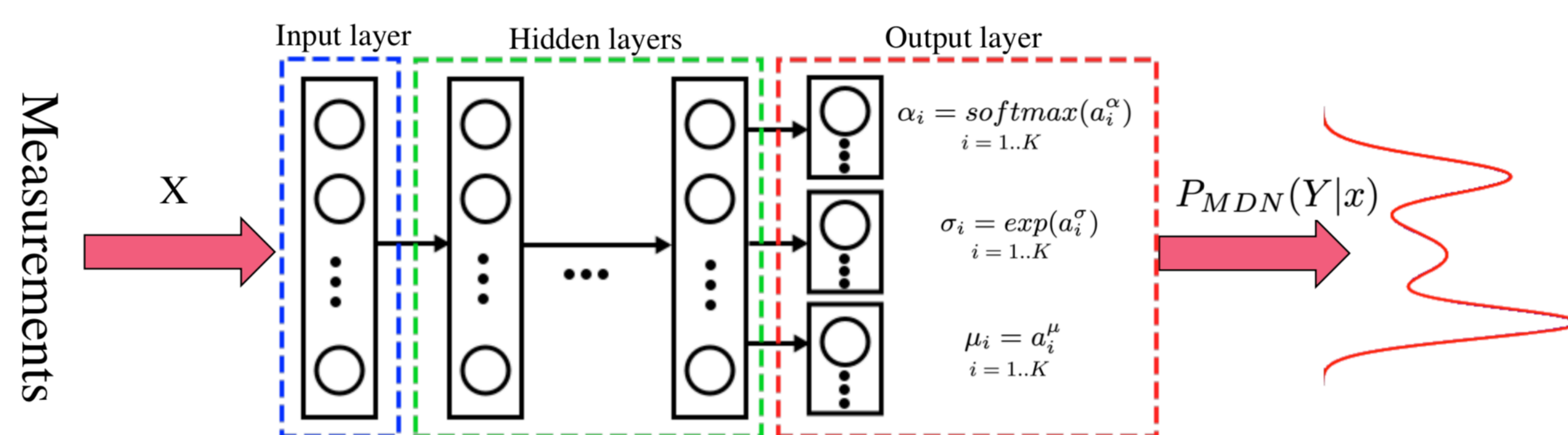
Mapping local statistics to service metrics



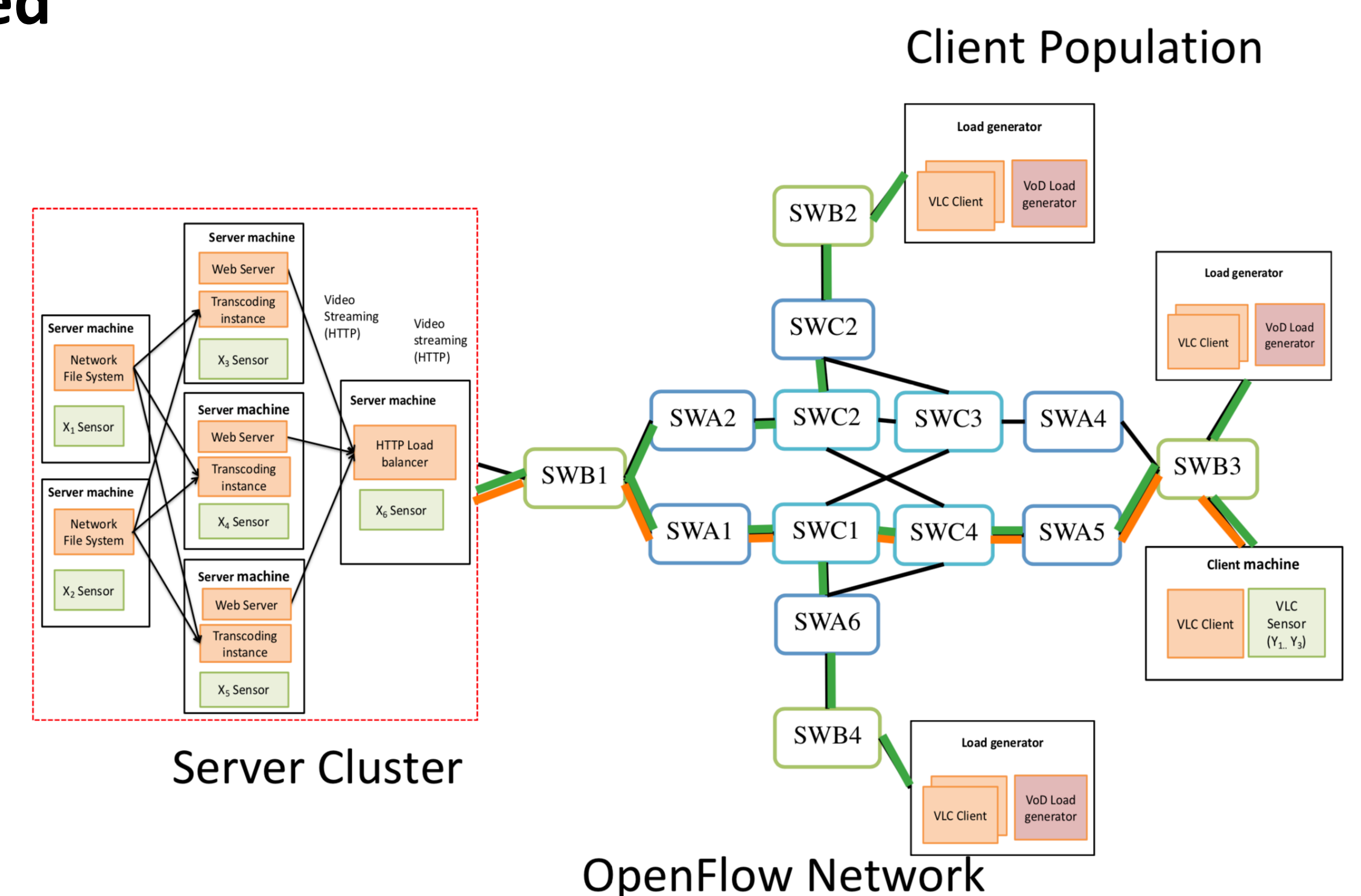
Modeling Conditional Distribution

- We model $P(Y|x)$ as a mixture of Gaussians.

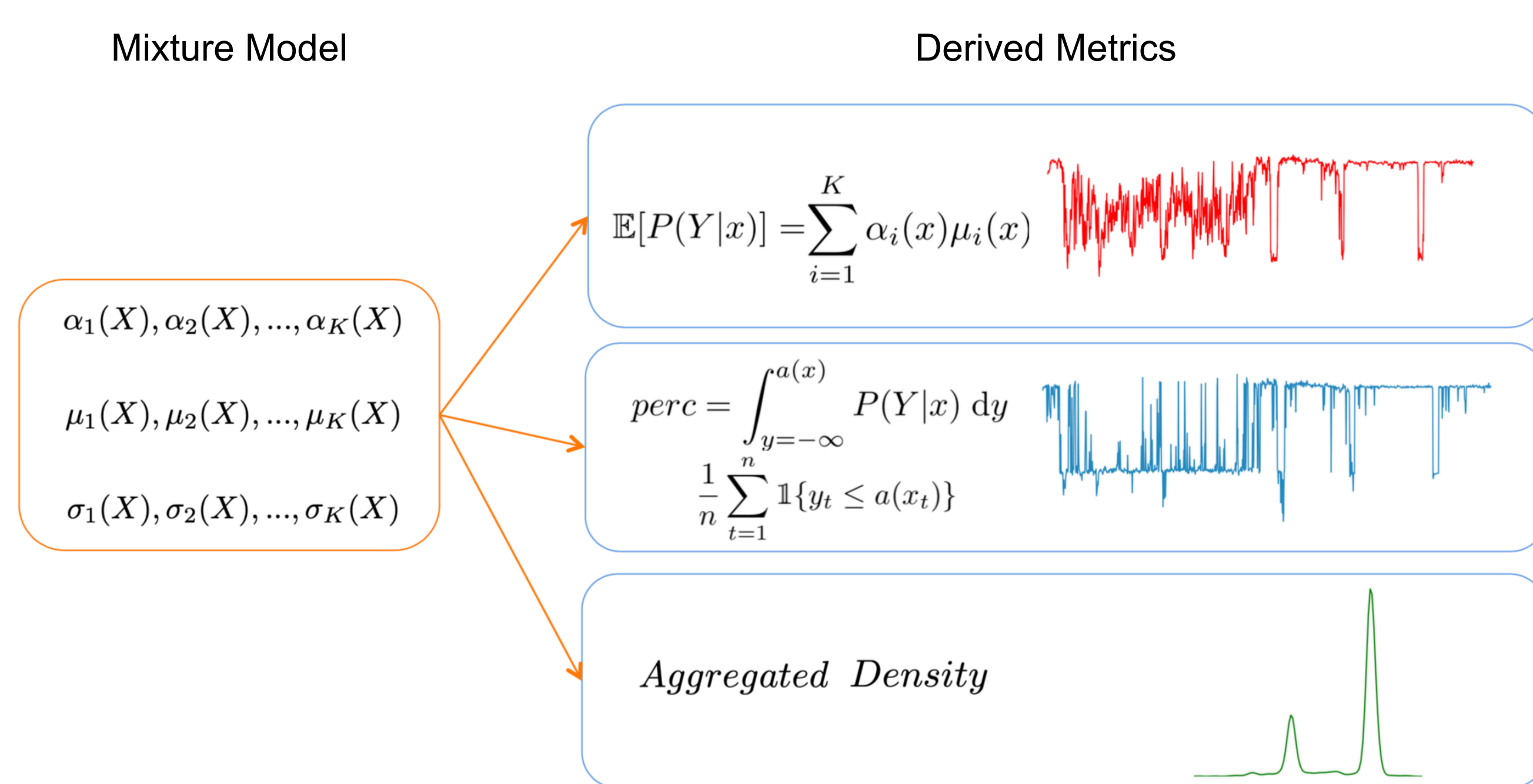
$$P(Y|x) = \sum_{i=1}^K \alpha_i(x) \phi_i(Y|x) \quad \phi_i(Y|x) = \frac{1}{(2\pi)^{\frac{1}{2}} \sigma_i(x)} \exp\left\{-\frac{\|Y - \mu_i(x)\|^2}{2\sigma_i(x)^2}\right\}$$



Testbed

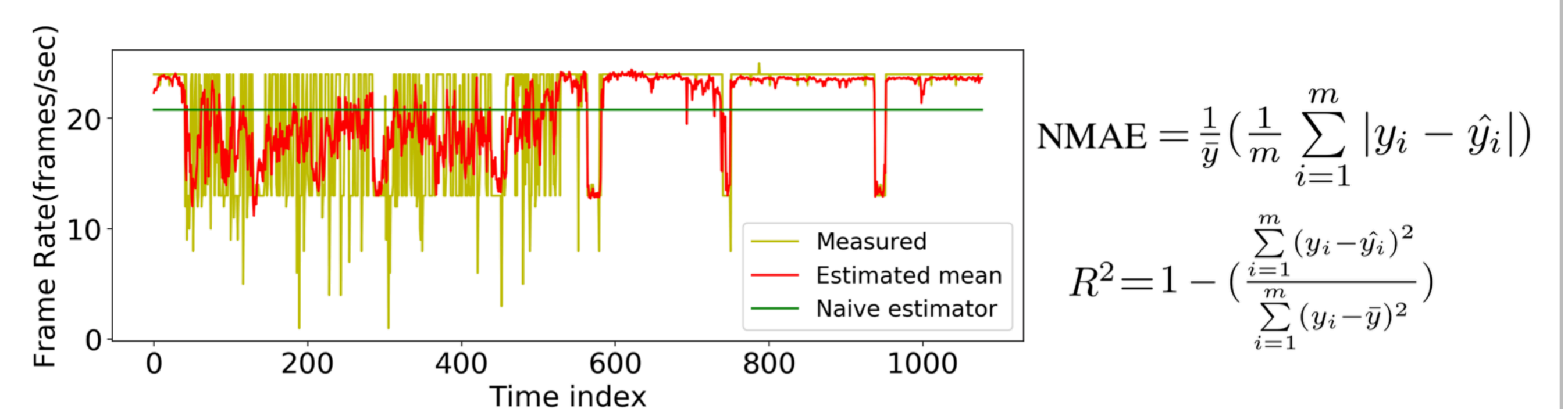


Metrics to evaluate mixture model



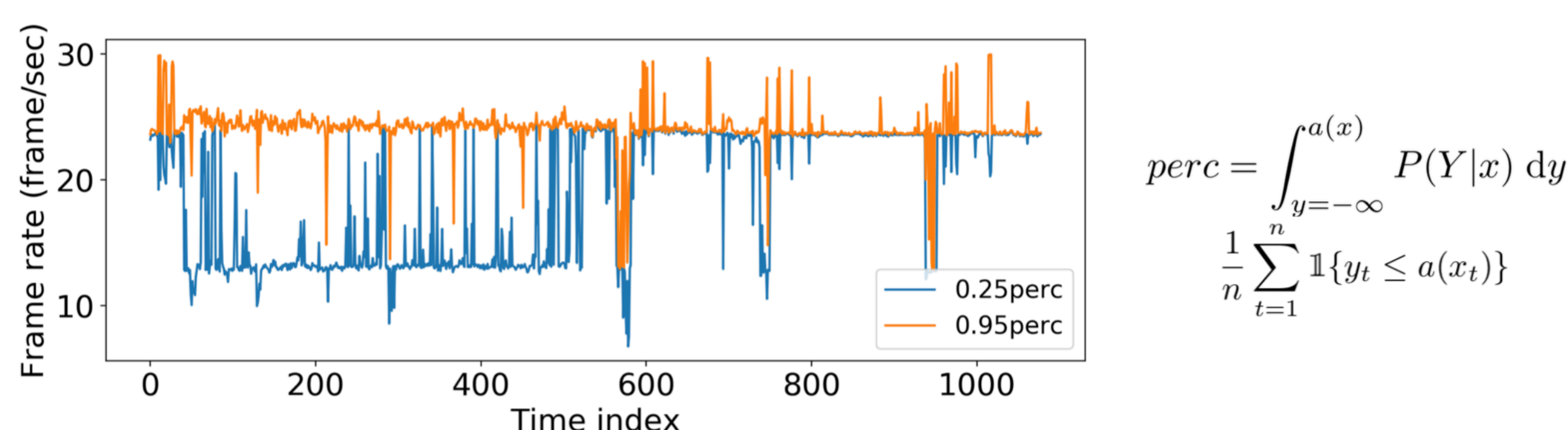
Predicting Expectations

Scenario	Train		Test		K
	NMAE	R ²	NMAE	R ²	
S1: VoD Periodic Load	0.10	0.53	0.12	0.43	6
S2: VoD Flash-crowd Load	0.08	0.44	0.08	0.43	4
S3: KV Periodic Load	0.024	0.52	0.027	0.26	4
S4: KV Flash-crowd Load	0.019	0.71	0.020	0.59	4

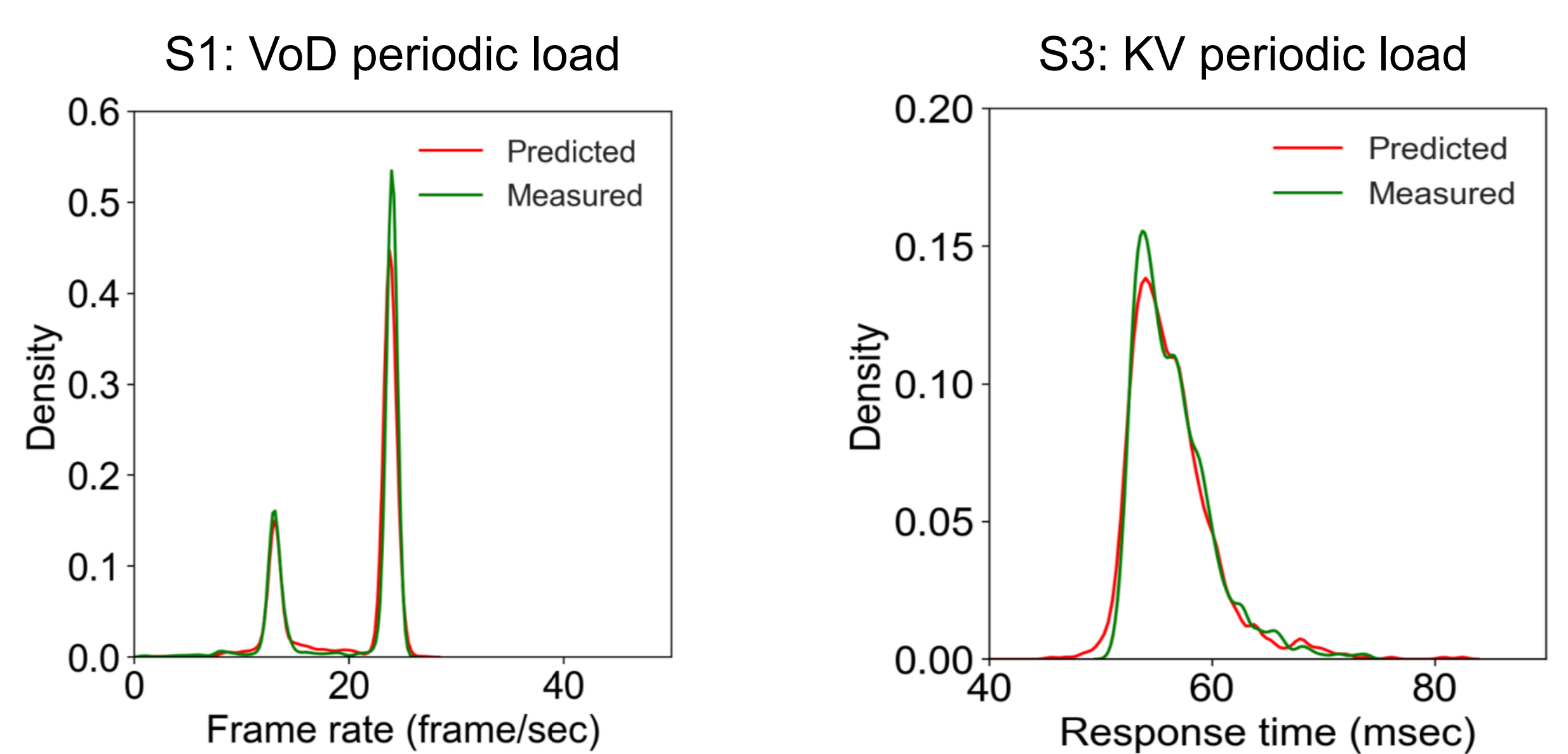


Predicting Percentiles

Scenarios	0.25 perc	0.50 perc	0.95 perc	K
S1: VoD Periodic Load	0.31	0.52	0.94	6
S2: VoD Flash-crowd Load	0.26	0.54	0.90	4
S3: KV Periodic Load	0.25	0.49	0.94	4
S4: KV Flash-crowd Load	0.24	0.49	0.90	4



Predicting Aggregated Density



- [1] F. S. Samani and R. Stadler, "Predicting distributions of service metrics using neural networks," in 2018 14th International Conference on Network and Service Management (CNSM). IEEE, 2018, pp. 45–53.
- [2] F. S. Samani, R. Stadler, A. Johnsson, and C. Flinta, "Demonstration: Predicting distribution of service metrics," in 2019 IFIP/IEEE Symposium on Integrated Network and Service Management (IM). IEEE, 2019.
- [3] F. S. Samani, R. Stadler, C. Flinta, and A. Johnsson, "Conditional density estimation of service metrics for networked services," IEEE Transaction on Networks and Service Management. (Submitted for publication)