

# USE CASES (5G / EDGE COMPUTING)

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“MODEL-DRIVEN AND AI-ENABLED INTER-CLOUD  
OPTIMIZATION,  
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# INTER-DC VIRTUAL FUNCTION PLACEMENT & RESOURCE MGMT

Map users to VNFs on DCs based on latency, availability, DC load, energy, mobility

Dynamically direct new user flows to utilize VNFs at the most appropriate DCs

Dynamically divert new VNF resource requirements away from a DC if heavily loaded

## *Example Depiction – Serving users in Sunnyvale and Cupertino CA*

Arizona DC (Solar  
Powered)

*Low Energy cost, Higher Latency*

San Francisco DC

*High Energy cost, Medium Latency,  
Higher Capacity compared to Small  
DC*

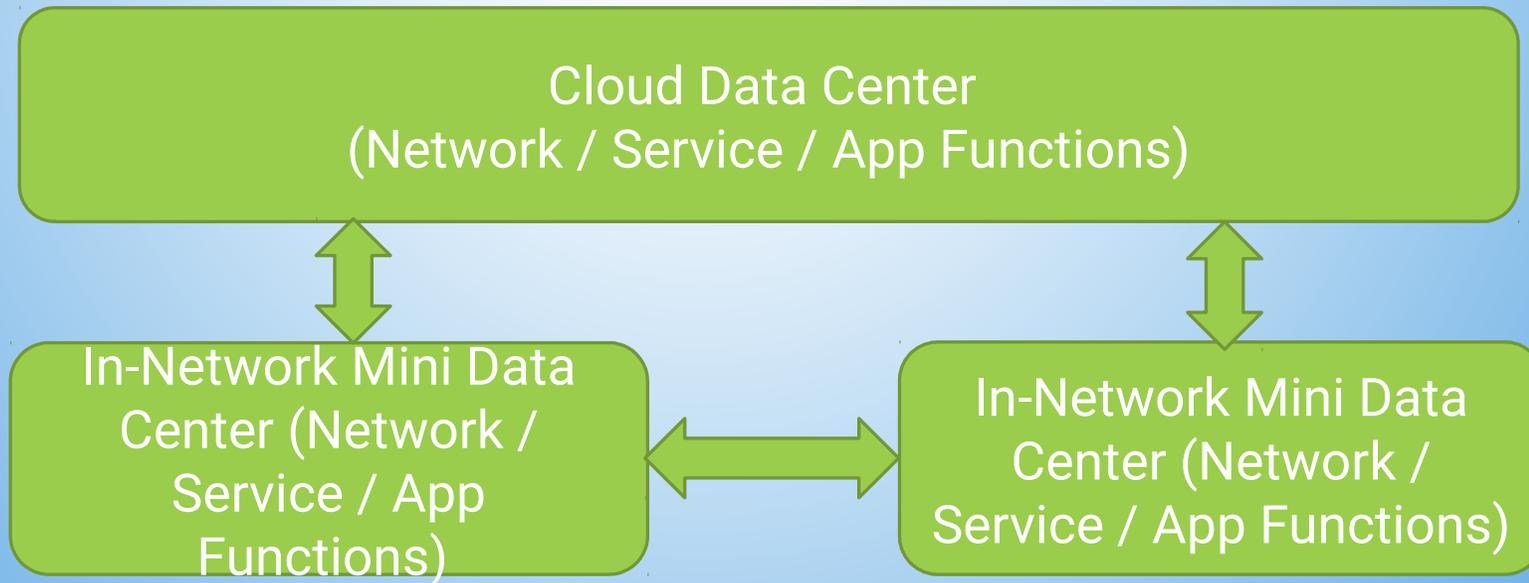
Cupertino Small  
DC

Sunnyvale Small  
DC

*Lower Latency, Lower  
Capacity  
High Energy Cost*

## DISTRIBUTED FUNCTIONS VIRTUALIZATION (DFV)

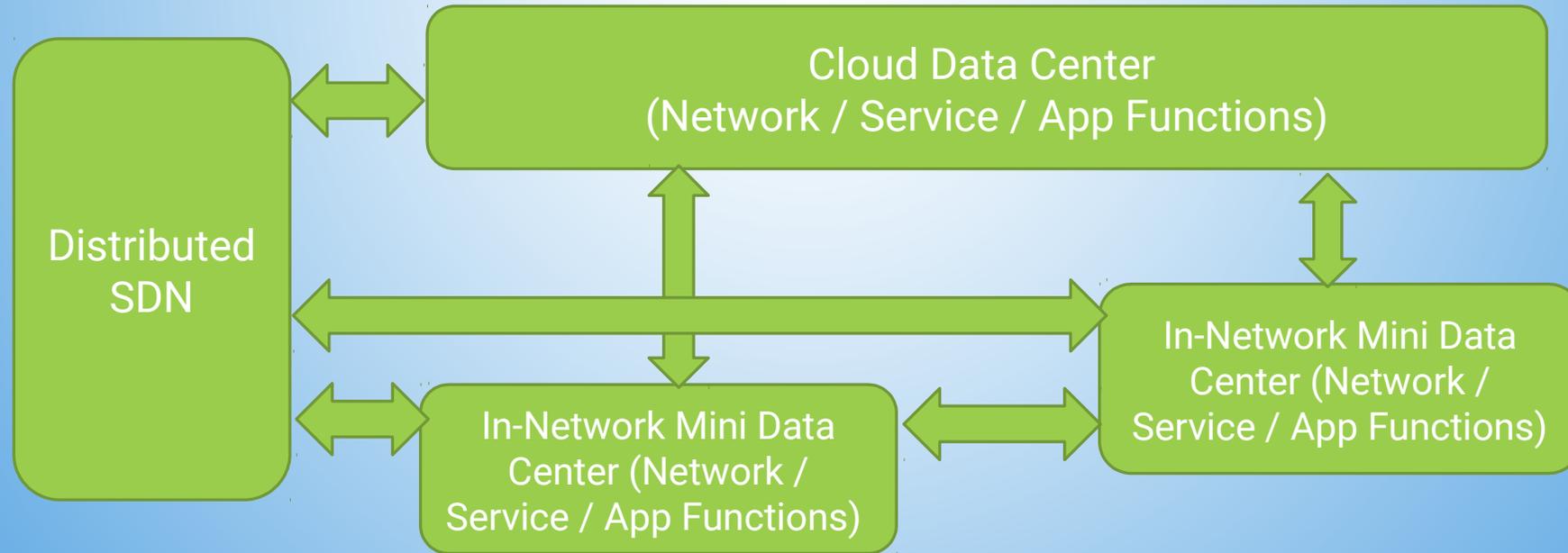
With the availability of compute & storage in-networks, explore the placement of network / service / application functions across DCs



- *How can we best place VNFs in hierarchical data centers taking care of latency constraints associated with VNFs, user mobility, energy cost of utilization, resource availability*
- *How can we best utilize the dynamic availability of such distributed compute/network/storage/energy resources?*

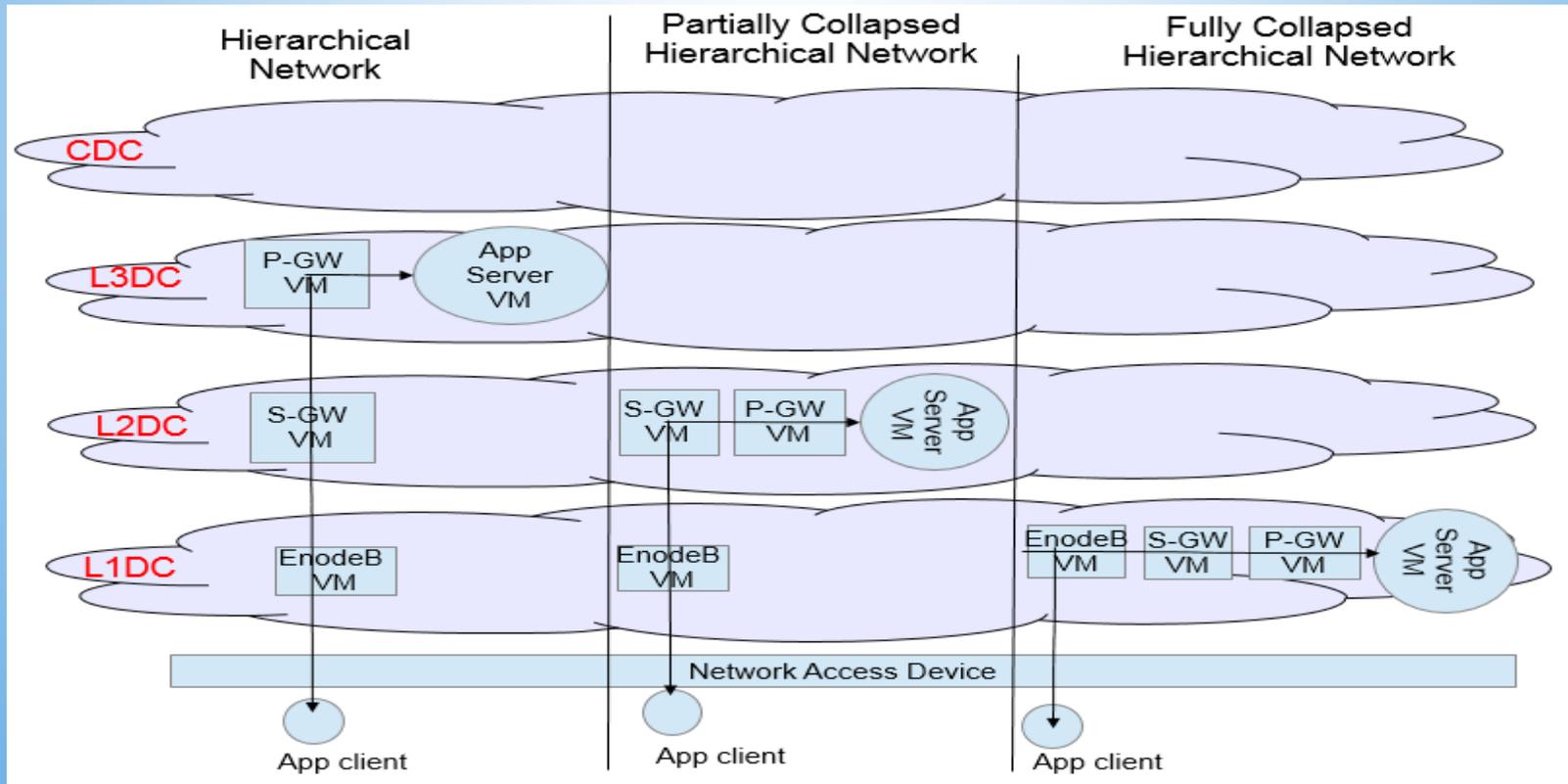
# DISTRIBUTED SDN FOR DISTRIBUTED NFV

Distributed SDN and NFV will enable smart distributed processing of functions across data centers



- *Partition / Collapse / Replicate functions across data centers*
- *Address latency constraints, user mobility, dynamic resource availability, security (compute/network/storage/energy)*
- *Dynamic Monitoring, Analytics, Optimization, Orchestration, Scaling*

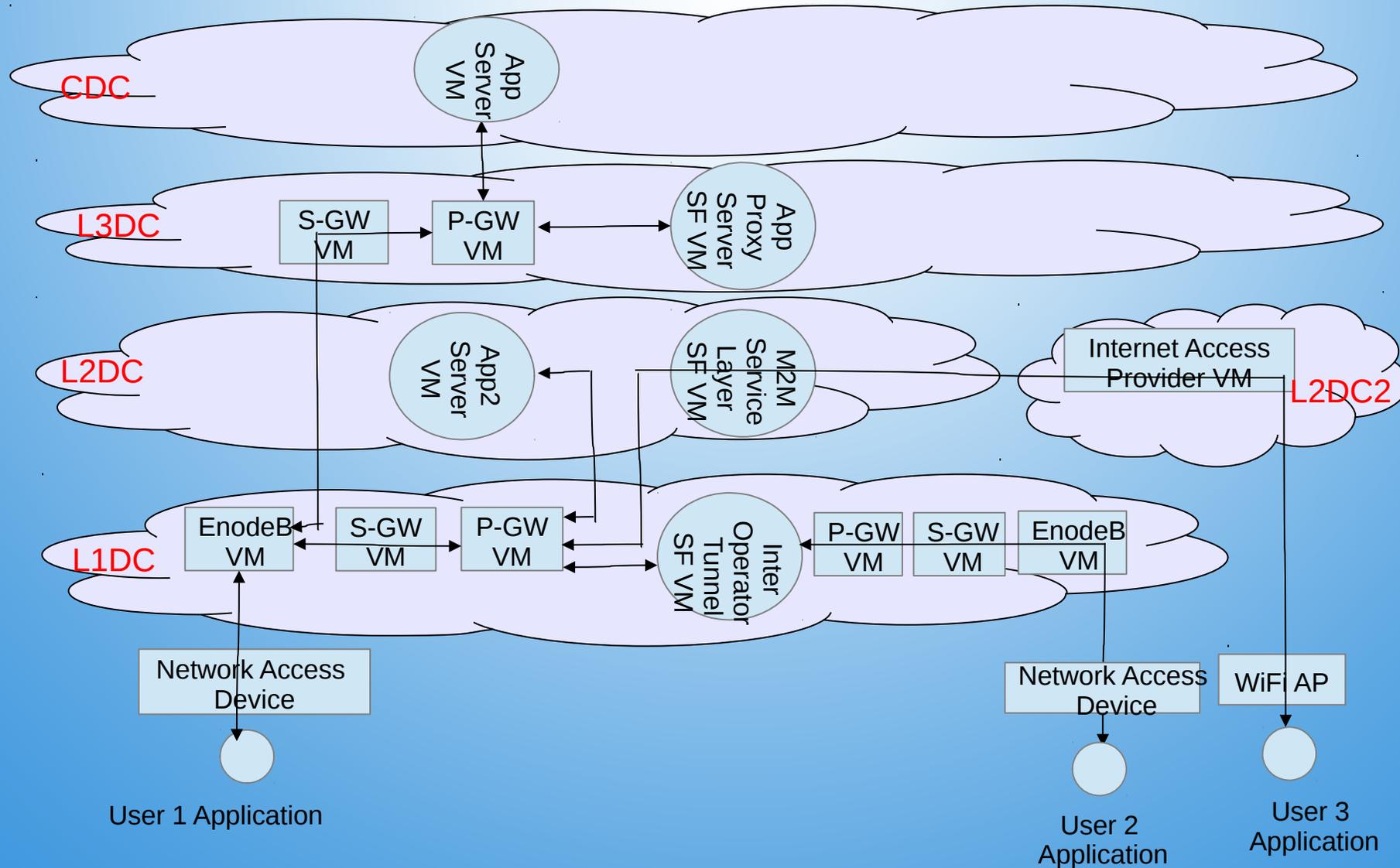
# HIERARCHICAL COLLAPSED FUNCTIONS (IEEE NFV-SDN'15)



Metric	Fully Hierarchical	Partially Collapsed	Fully Collapsed
Round trip time	179 ms (median)	64 ms (median)	22 ms (median)
Connection setup	3.7 sec (median)	1.3 sec (median)	0.7 sec (median)
TCP bandwidth	3.19 Mbps	3.45 Mbps	3.72 Mbps
Playout Stalls	12	2	0

# GENERALIZED DFV (IEEE NFV-SDN 2015)

## NETWORK, SERVICE, AND APPLICATION FUNCTION VM PARTITIONING



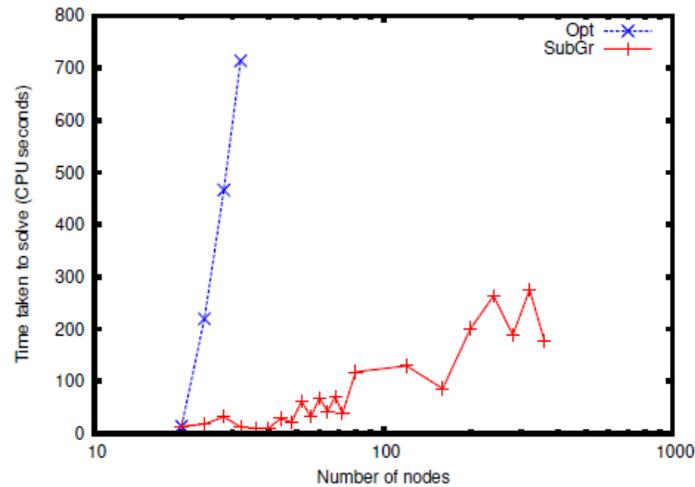
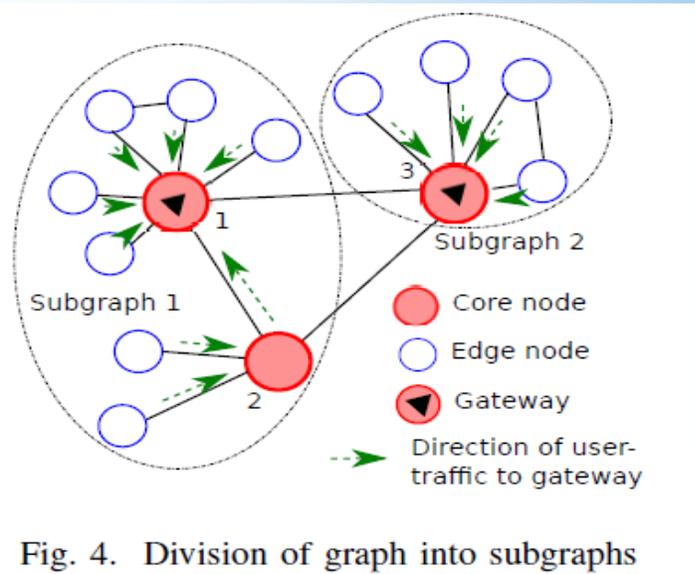
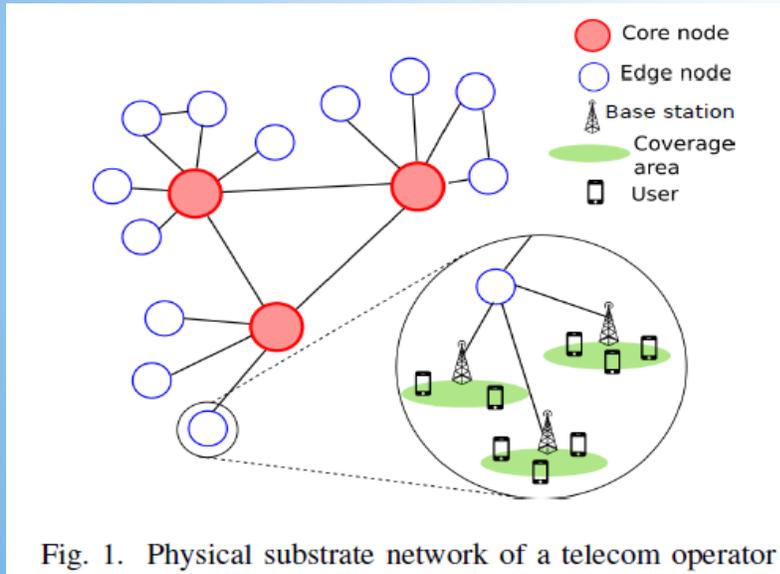


Fig. 8. Comparison of time taken to obtain the optimal placement by running model on complete graph vs subgraphs

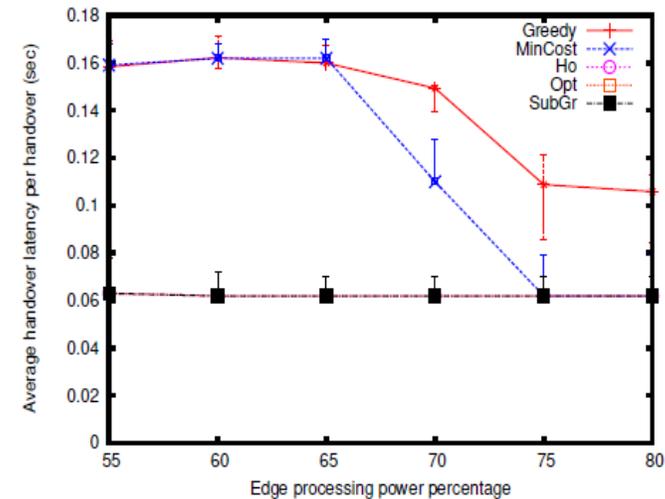


Fig. 6. Comparison of the average handover latency for different approaches (min, median, and max values have been plotted)

# EDGE COMPUTING/SERVICES

- Local Whatsapp
- Local Twitter
- Local Facebook
- Local Email
- Local Web
- Local VR/AR
- Local VCDN
- Local Banking
- Local Healthcare
- Local Emergency
- Local Traffic
- Local Weather
- Local Pollution
- Local Cognitive Apps
- Local Blockchains
- Local IoT Services (e.g. NB-IoT)



The background is a solid blue color with a subtle gradient. In the four corners, there are decorative white line-art patterns resembling circuit traces or a stylized tree structure. These patterns consist of thin lines connecting small circles, creating a network-like appearance.

# THANK YOU

- Questions?