

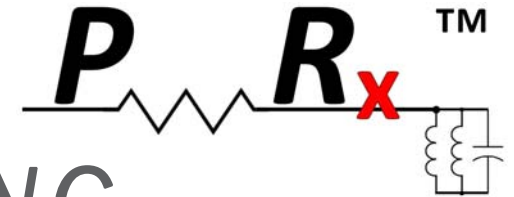


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OCP U.S. SUMMIT 2017

Santa Clara, CA



OCP SUMMIT '17 ENG. WORKSHOP:

5G: Redefining the Telco Data Center

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OUTLINE

- A Brief Introduction to 5G
- A Brief Introduction to SDN/NFV
- The Telco Data Center
- 5G is Changing the Landscape
- A Power Play
- CONCLUSIONS
- Q & A



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A Brief Introduction to 5G

- Market / Motivations

- The Winds of Change: Global User Shifts = Network Processing Shifts

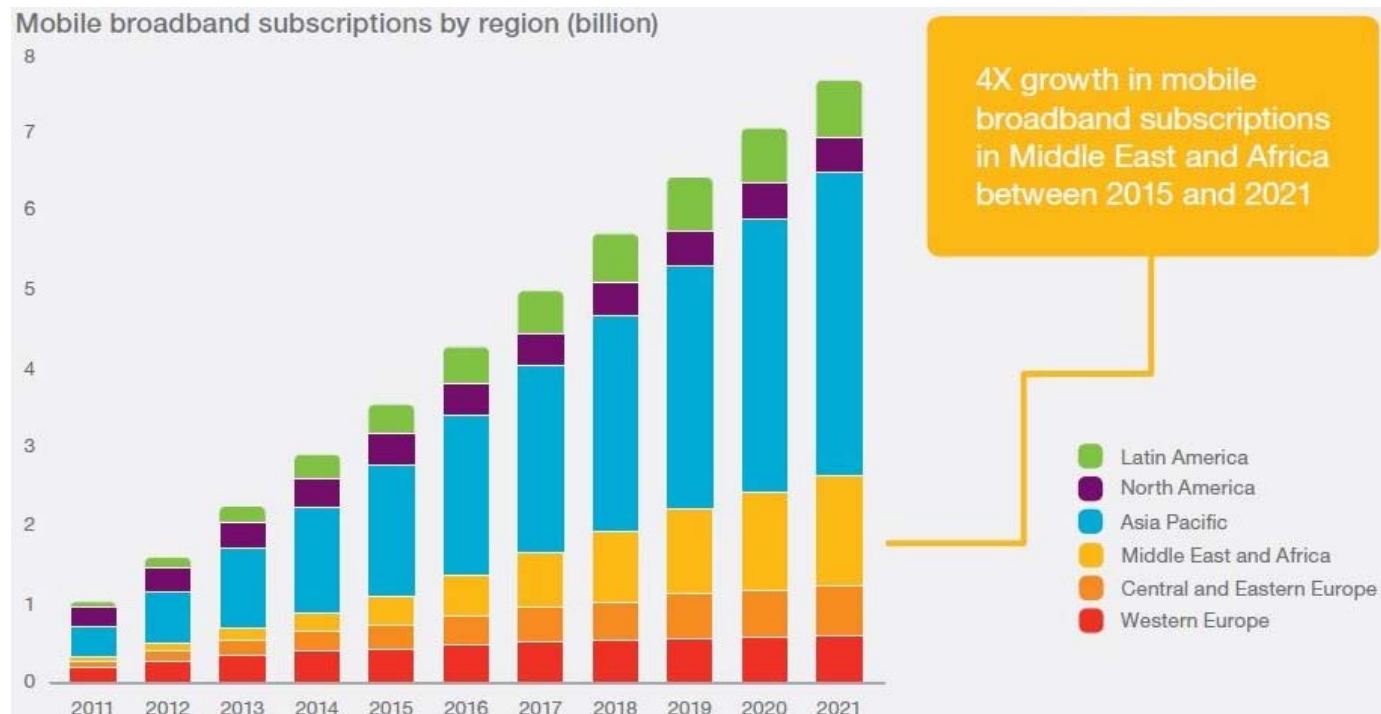


IMAGE CREDIT: "Ericsson Mobility Report," Ericsson, June 2016.

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A Brief Introduction to 5G

- Market / Motivations

- The Winds of Change: Global User Shifts = Network Processing Shifts

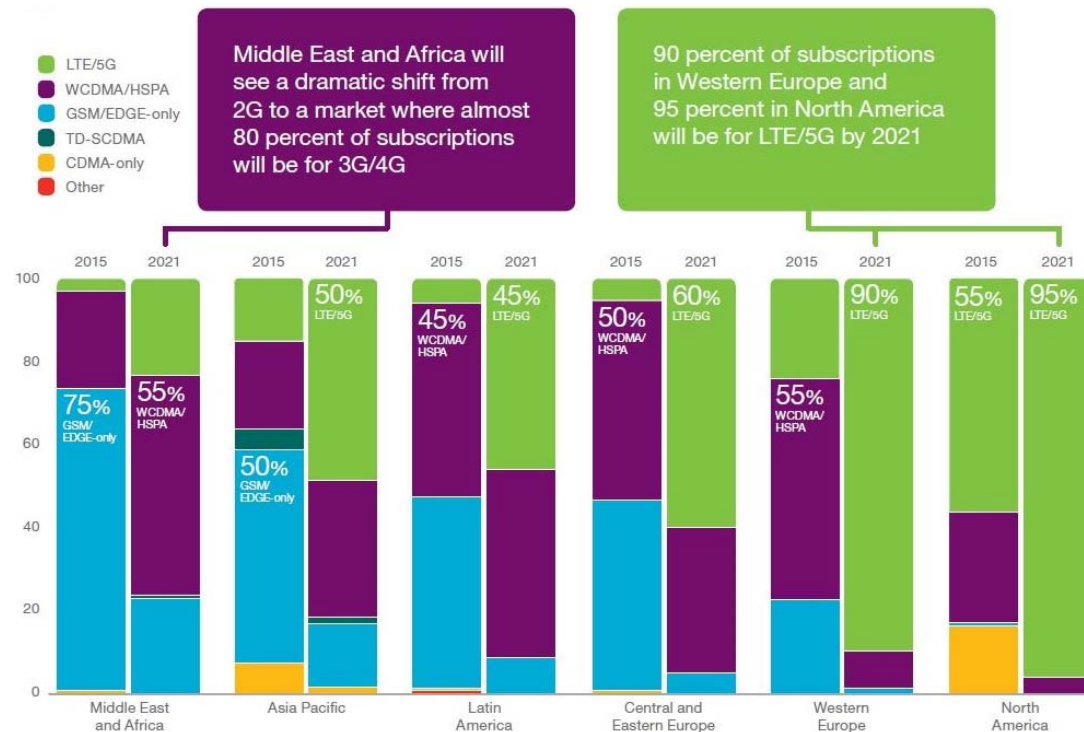


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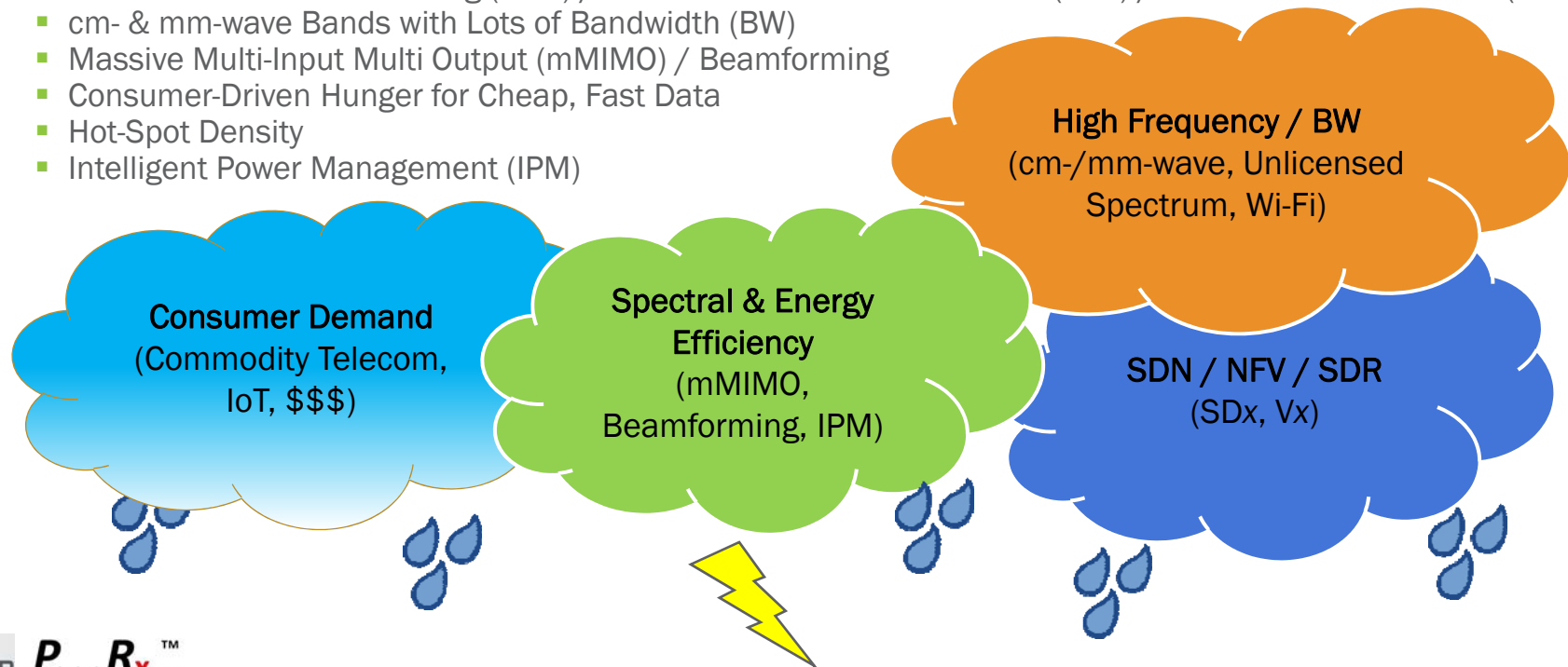
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A Brief Introduction to 5G

- Why 5G?

- The Perfect Storm

- Software-Defined Networking (SDN) / Network Function Virtualization (NFV) / Software-Defined Radio (SDR)
 - cm- & mm-wave Bands with Lots of Bandwidth (BW)
 - Massive Multi-Input Multi Output (mMIMO) / Beamforming
 - Consumer-Driven Hunger for Cheap, Fast Data
 - Hot-Spot Density
 - Intelligent Power Management (IPM)



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A Brief Introduction to 5G

- Why 5G?
 - The Benefits Speak for Themselves

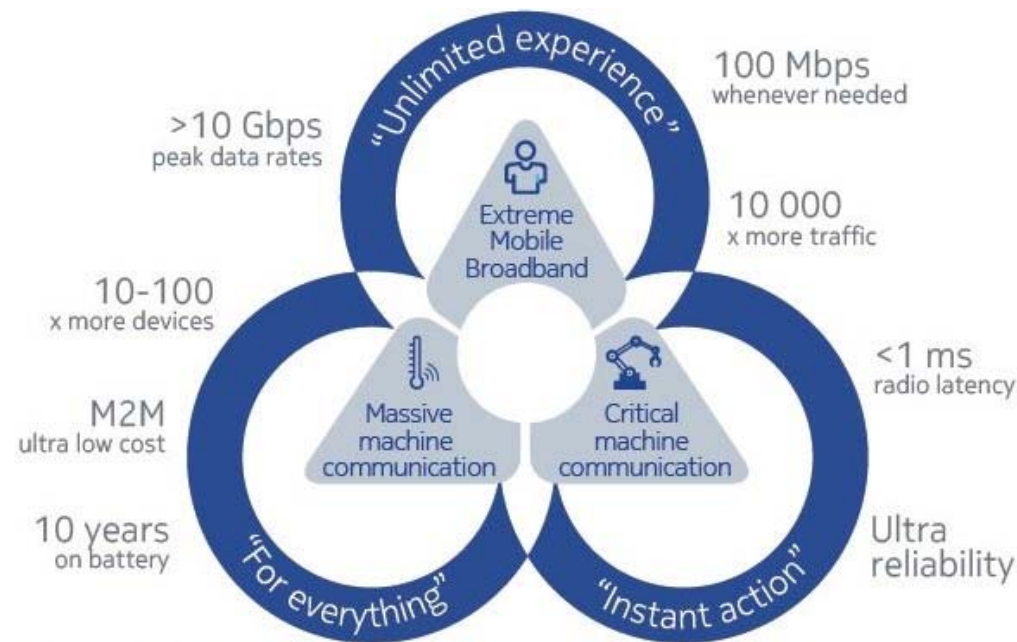


Figure 2. Heterogeneous use cases – diverse requirements

IMAGE CREDIT: "5G masterplan - 5 keys to create the new communications era.," Nokia, 2016.

A Brief Introduction to 5G

- What is 5G?
 - Everyone Has Their Own Definition



IMAGE CREDIT: "5G: 5 keys for creating the new communications era," Nokia, 2016.



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A Brief Introduction to 5G

- What is 5G?
 - Everyone Has Their Own Definition
 - Jury is still out and will be until 2020.
 - South Korea 2018 Winter Olympics
 - Japan 2020 Summer Olympics
 - EXAMPLE: EU 5GPPP's "Roadmap" to 5G

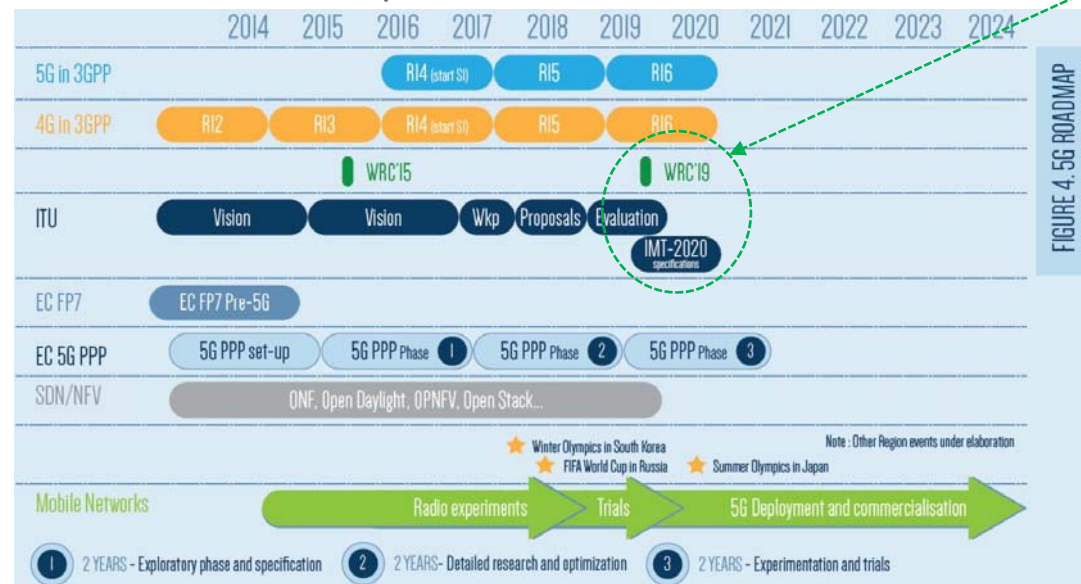


FIGURE 4: 5G ROADMAP

IMAGE CREDIT: "The 5G Infrastructure Public Private Partnership: the next generation of communication networks and services.," 5G Infrastructure Association, February 2015.



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A Brief Introduction to 5G

- What is 5G?
 - In a Nutshell

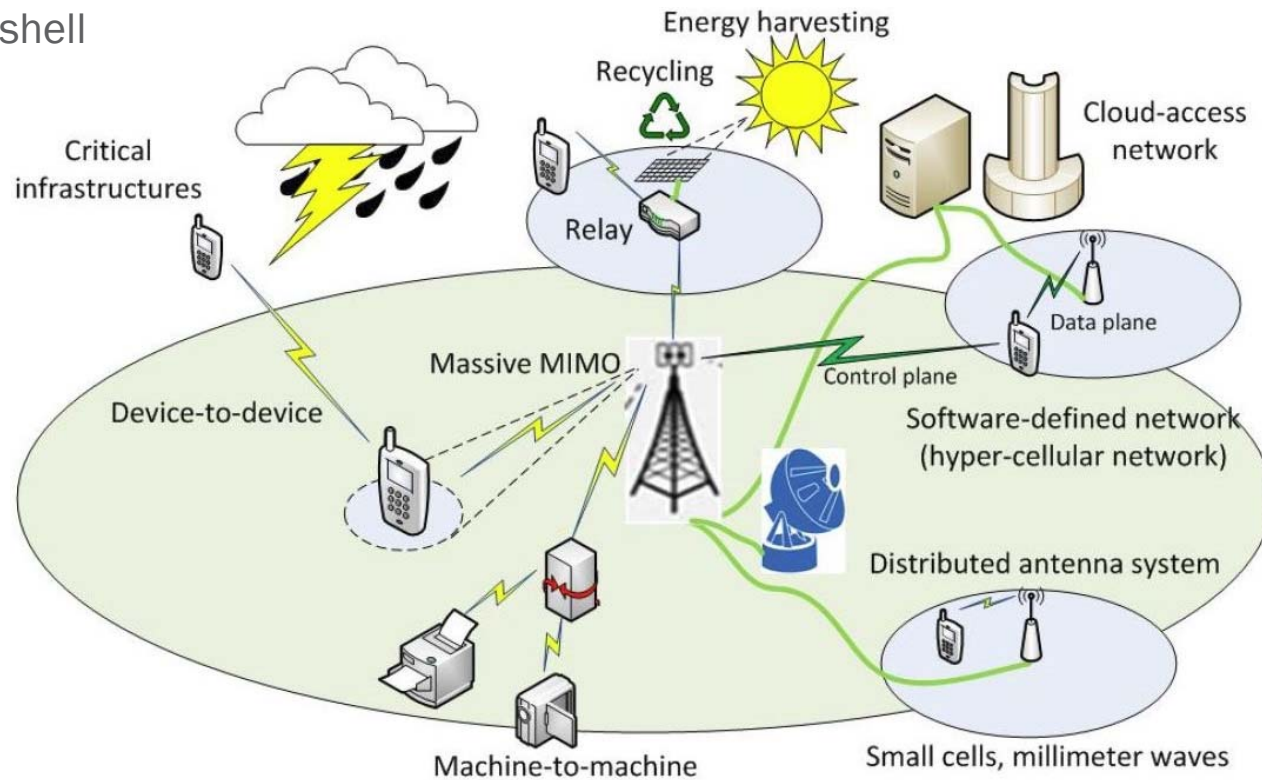


IMAGE CREDIT: A. Mammela, "Energy efficiency in 5G networks," IFIP Networking 2015, Toulouse, France, May 20, 2015.

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A Brief Introduction to 5G

- Heterogeneous Networks (HetNets)

- Small Cells

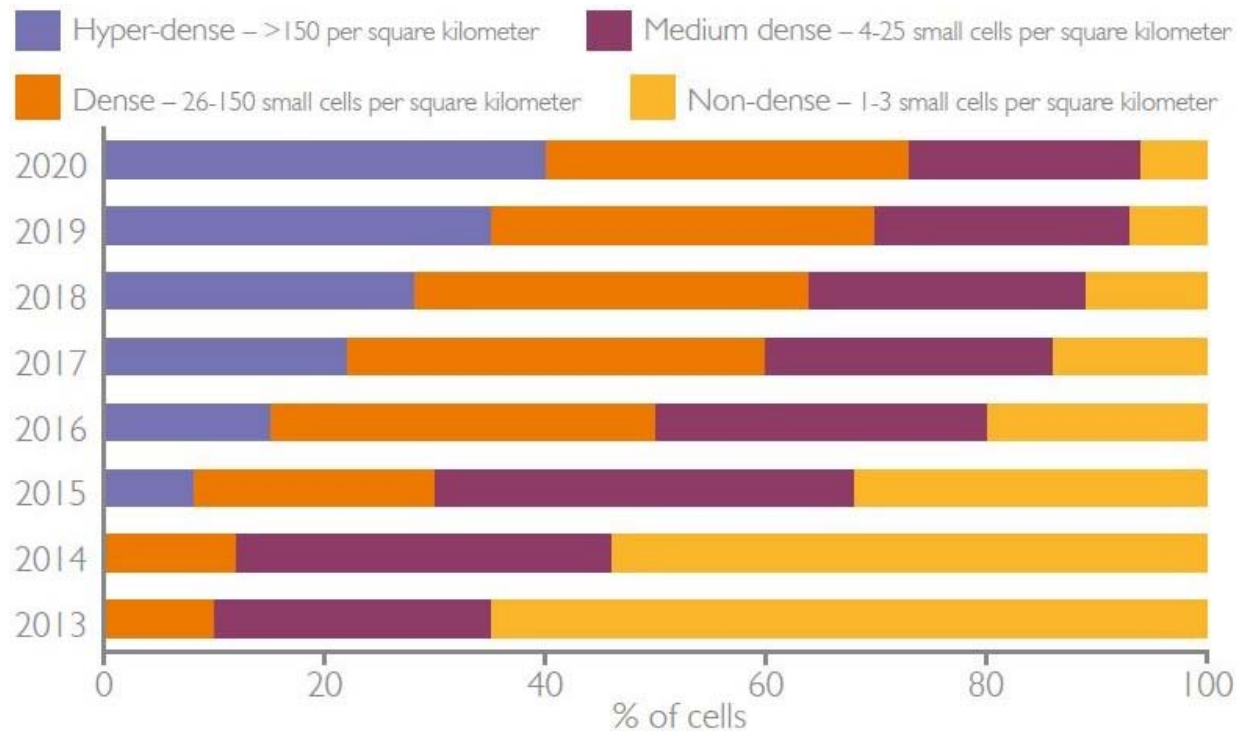


Figure 3. Percentage of small cells deployed in various levels of density 2013-2020

IMAGE CREDIT: "Crossing the Chasm: Small Cells Industry November 2015," Smart Cell Forum, November 2015.



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A Brief Introduction to 5G

- Disaggregation
 - Enables Densification
 - Commodity Where You Need It
 - Optimize, Optimize, Optimize
- Mobile Edge Computing (MEC)
 - Bringing Compute to the Edge
 - Buffering Common / Bandwidth Intensive Loads (i.e. – Video Streaming)
- Lots of Cool RF Stuff (*outside scope for today*)
 - mm-wave
 - mMIMO
 - SDR



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A Brief Introduction to SDN/NFV

- The Software-Defined Data Center
 - Pretty self-explanatory, right?

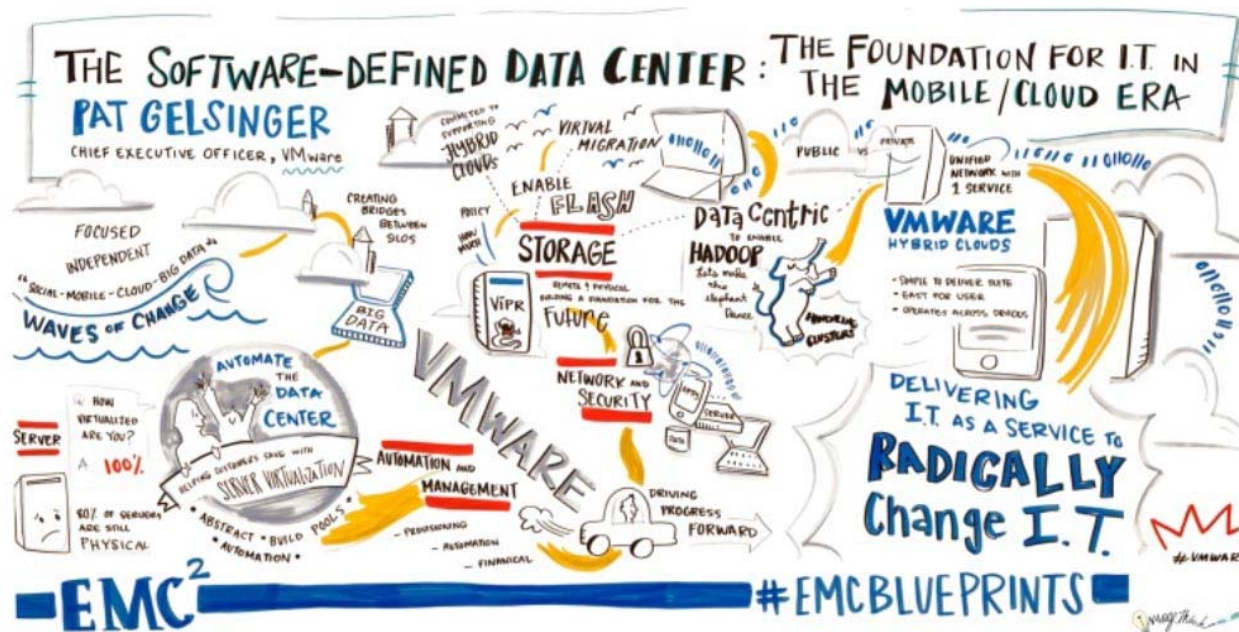


IMAGE CREDIT: <https://www.emc.com/ppg/csp/sw-des-data-ctr.htm>



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A Brief Introduction to SDN/NFV

- The Software-Defined Data Center
 - Ok, a little more realistically.

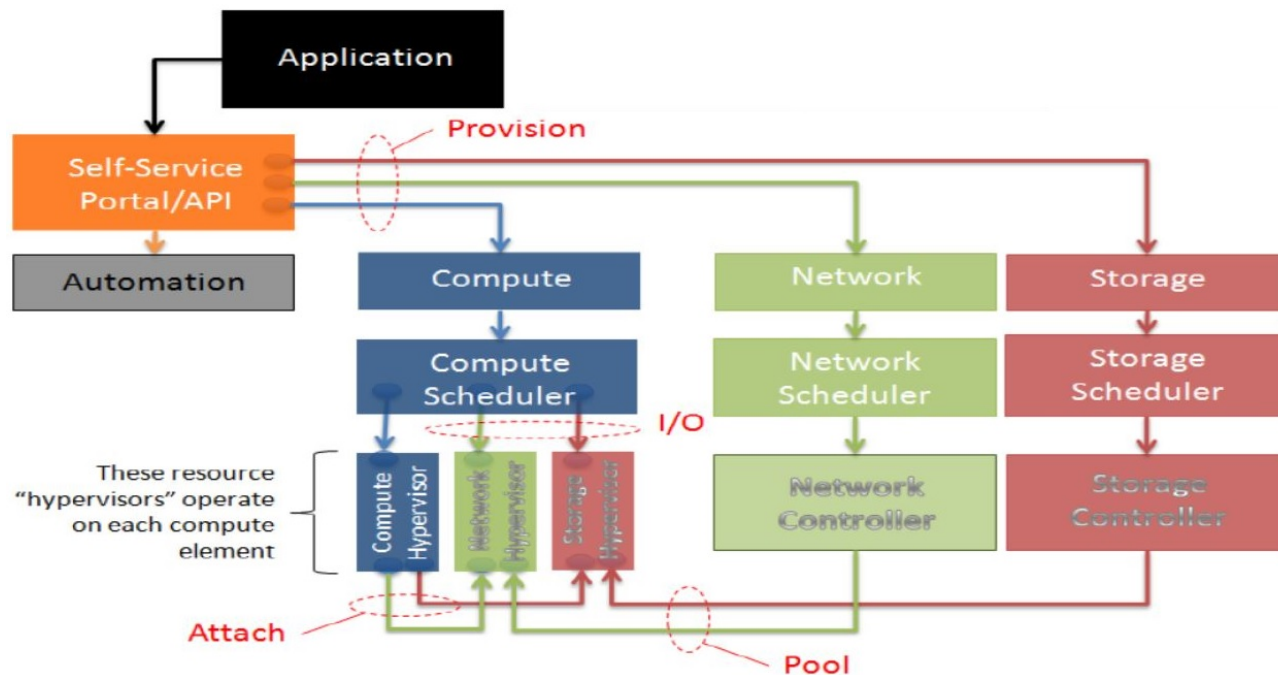


IMAGE CREDIT: Dave Cohen, "Software Defined Data Center: The Intersection of Networking and Storage," EMC World 2013, 2013.

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A Brief Introduction to SDN/NFV

- Software-Defined Networking (SDN)

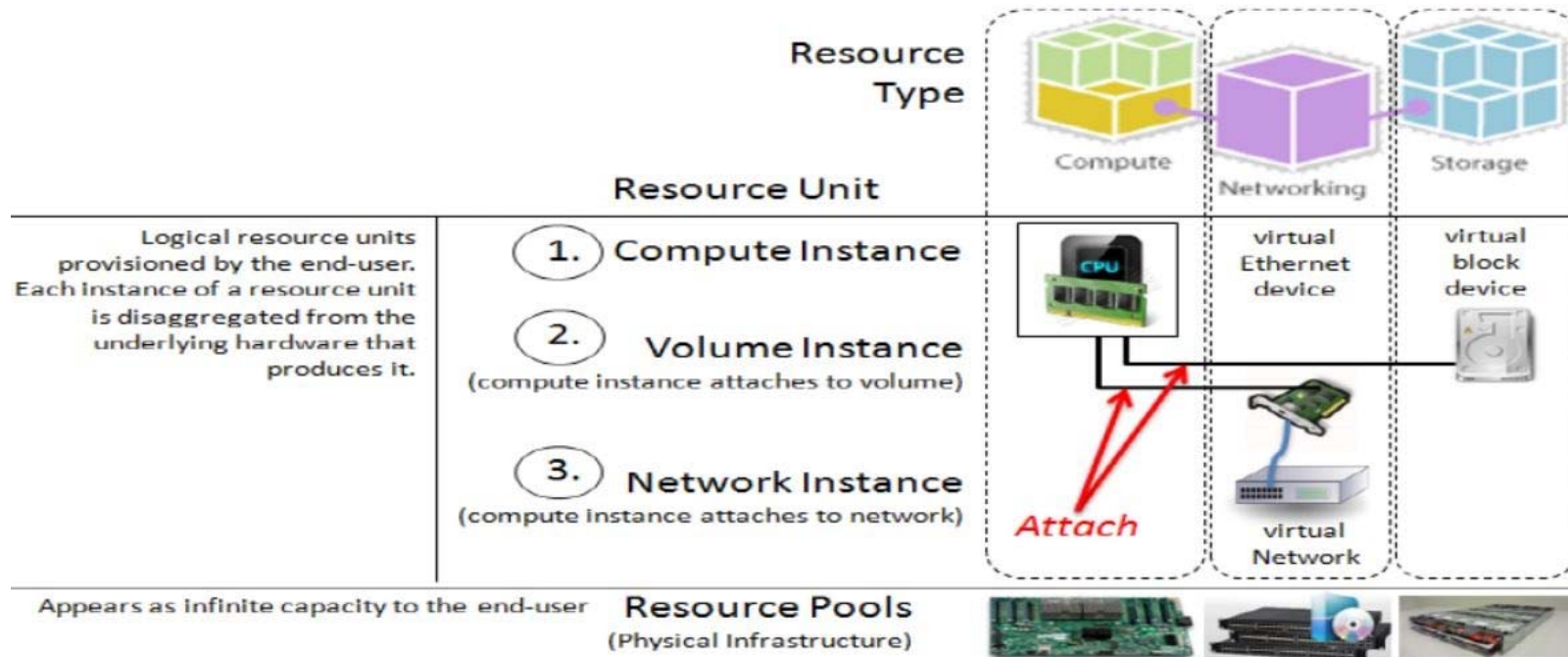


IMAGE CREDIT: Dave Cohen, "Software Defined Data Center: The Intersection of Networking and Storage," EMC World 2013, 2013.

A Brief Introduction to SDN/NFV

- Network Function Virtualization (NFV)

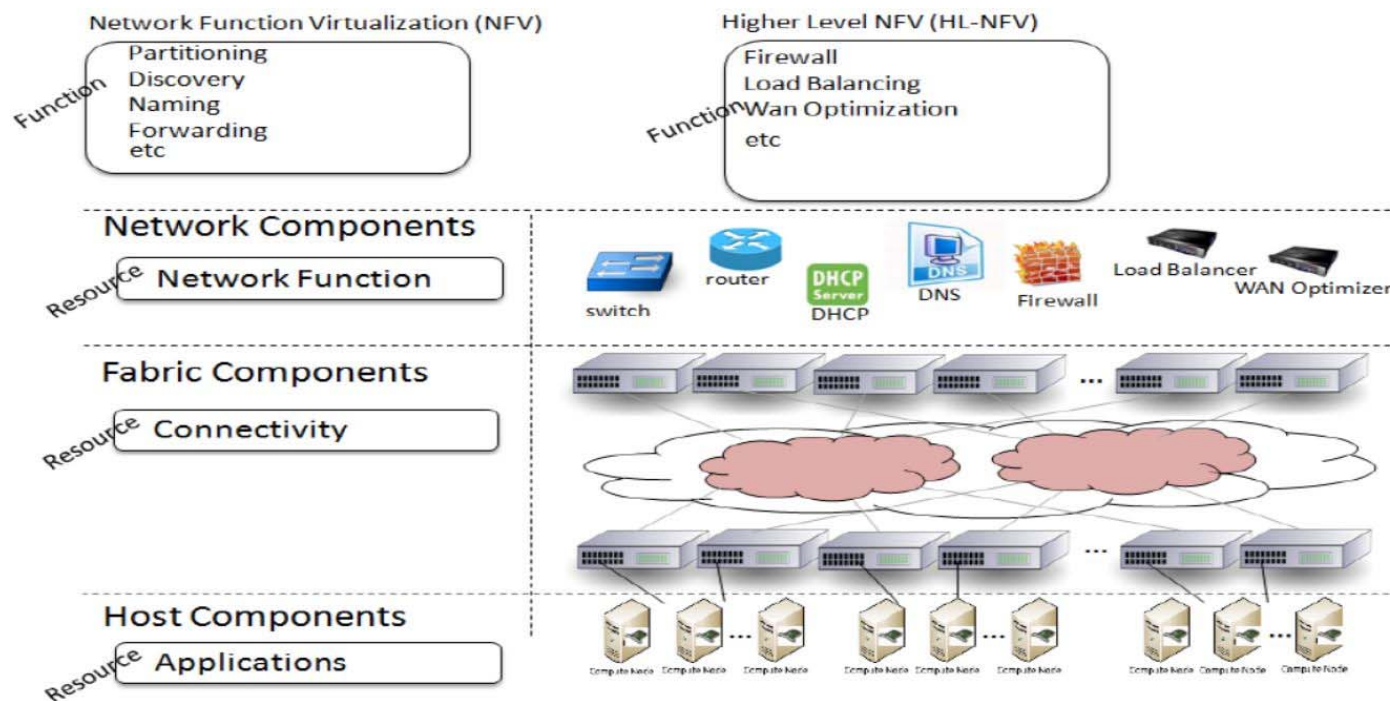


IMAGE CREDIT: Dave Cohen, "Software Defined Data Center: The Intersection of Networking and Storage," EMC World 2013, 2013.



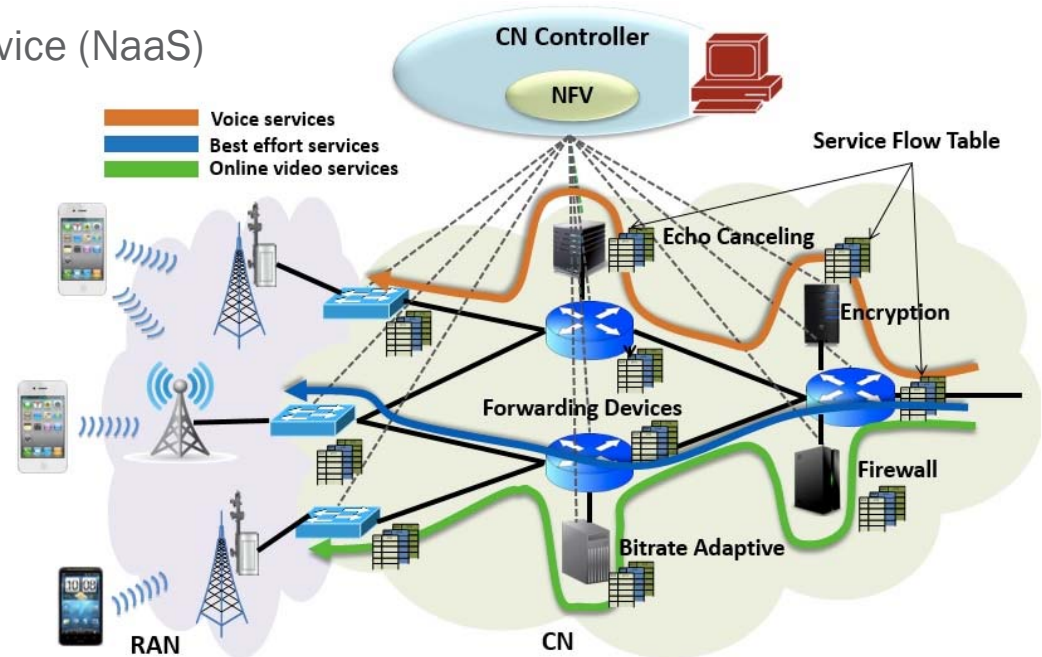
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A Brief Introduction to SDN/NFV

- 5G Application: Nice or Necessity?

- An Absolute Necessity
- Seamless Sharing Across Base Stations & Networks
- Network Slicing = Network-as-a-Service (NaaS)
- Software-Defined Radio (SDR)
- Service-Based Optimization



The Telco Data Center

- Differentiation from Typical Data Center
 - DC Distribution
 - Back-up Power (i.e. – Uptime)
 - Network Equipment – Building System *OR* NEBS Requirements (i.e. – More Ruggedized HW)
- Where are the watts being consumed?
 - Intelligent Power Management (IPM)
 - *...more on this later.*
- Base station, data center, or both?



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The Telco Data Center

- Really Simplified Version

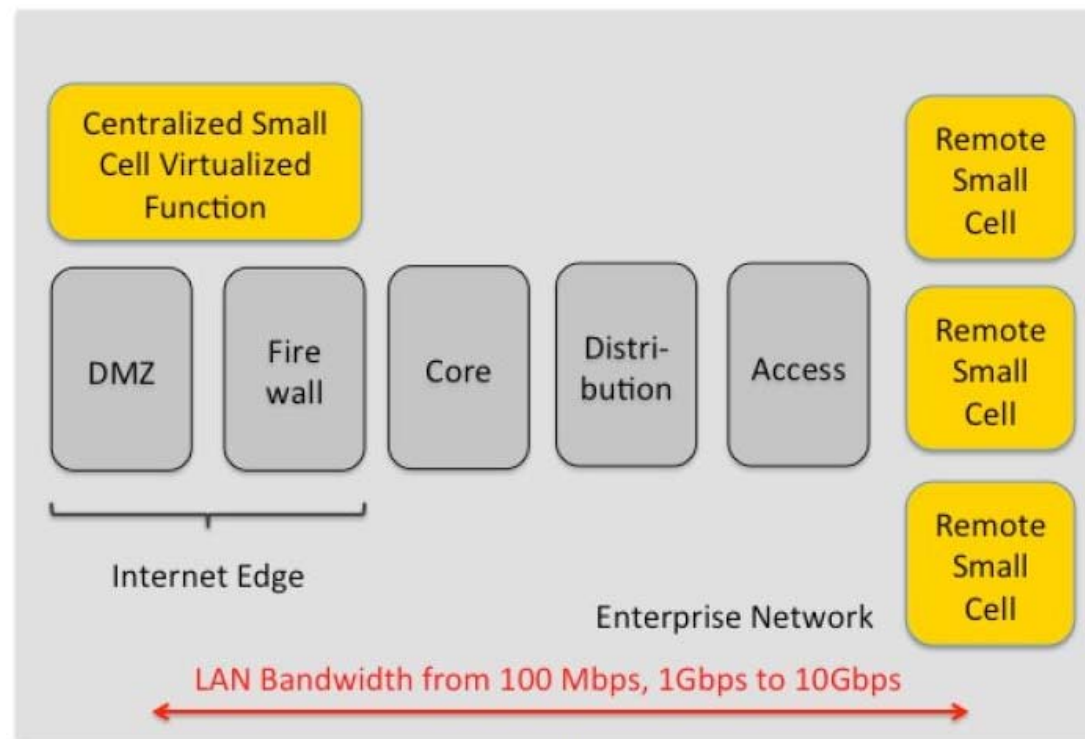


Figure 5-3 Mapping of virtualized small cell to enterprise 3-tier network

IMAGES CREDIT: "Network aspects of virtualized small cells," Smart Cell Forum, June 2015.



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The Telco Data Center

- Really Simplified Version

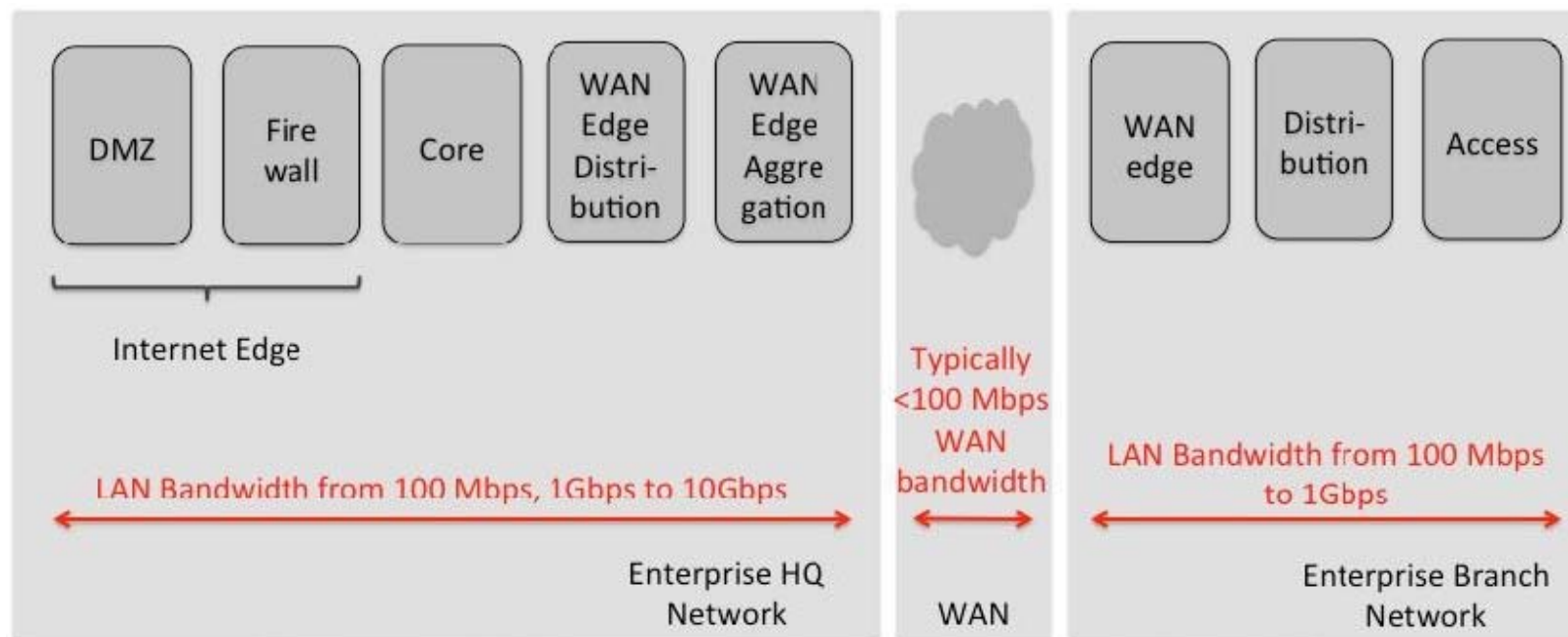


Figure 5-4 WAN service connectivity to enterprise remote branch network

IMAGES CREDIT: "Network aspects of virtualized small cells," Smart Cell Forum, June 2015.



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5G is Changing the Landscape

- 4G-LTE Has Already Brought SDN/NFV to Telco Networks
- Small Cells
 - Cell Network Virtualization?!? (i.e. – Bunch of Small Cells Become a Giant HetNet)
 - Network Slicing
- MEC Shifts Utilization
 - Buffering at the Edge...*more on this in a moment.*



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A Power Play

- MEC Potential for Massive Power Savings
 - Base Station Caching
 - Tricking the Consumer Into Footing the Bill
 - *EXAMPLE:* Is Grandma okay?



IMAGE CREDIT: <http://sciencepole.com/ive-fallen-cant-get/>

A Power Play

- Small Cells Yield Energy Independence
 - Microgrids
 - Fault-Tolerance
 - Energy Harvesting
- Disaggregation Simplifies Optimal Utilization
 - Bringing Steady-State to Dynamic Load Schemes
 - Put Stuff to Sleep



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CONCLUSIONS

- There is a lot of agreement on what 5G should be, but not as much on what it is and when it will fully come to fruition.
- The base station is becoming the data center.
- IPM is the key to enabling 5G!
- SDx / Vx is an integral part of the 5G data center / network and is here to stay.
- Architectural & operational shifts to the telco network will yield many paradigm shifts in power utilization.



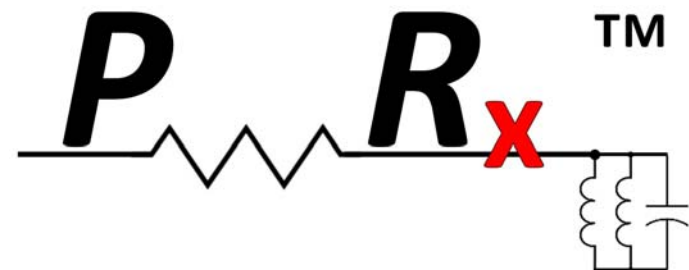
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Q & A

Thanks for your attention!!!

Questions/Comments???



REFERENCES

- "Ericsson Mobility Report," Ericsson, June 2016.
- "5G masterplan - 5 keys to create the new communications era.," Nokia, 2016.
- "5G: 5 keys for creating the new communications era," Nokia, 2016.
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