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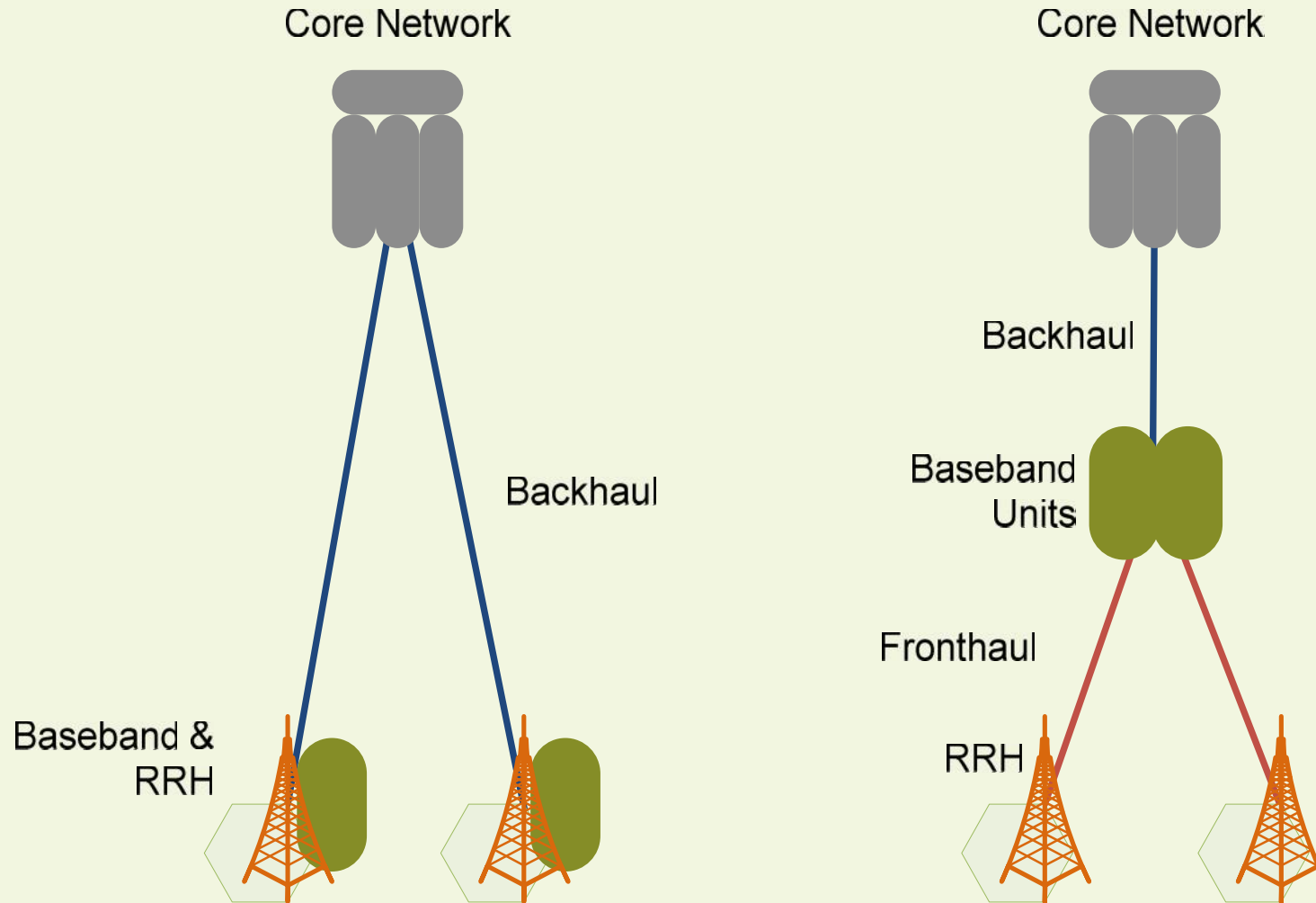
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Expected Performance Benefits from Cloud RAN

Fronthaul & CRAN 2014

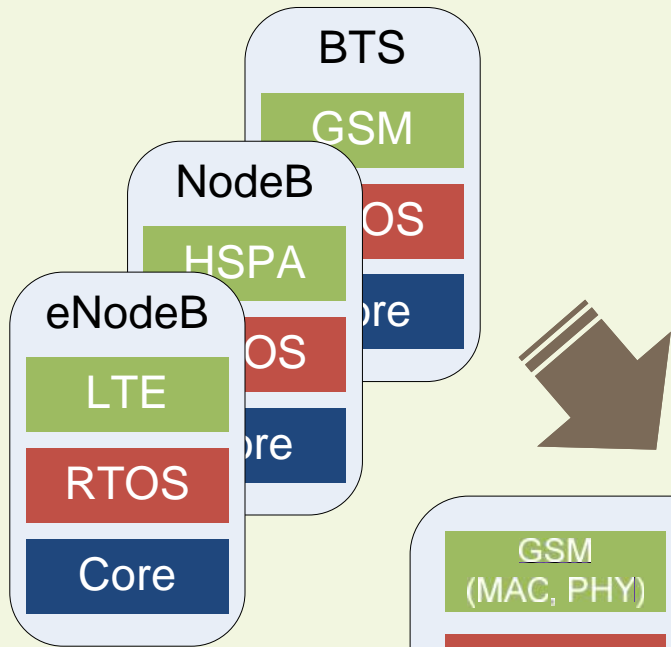
October 29, 2014

Cloud RAN: Baseband Virtualization

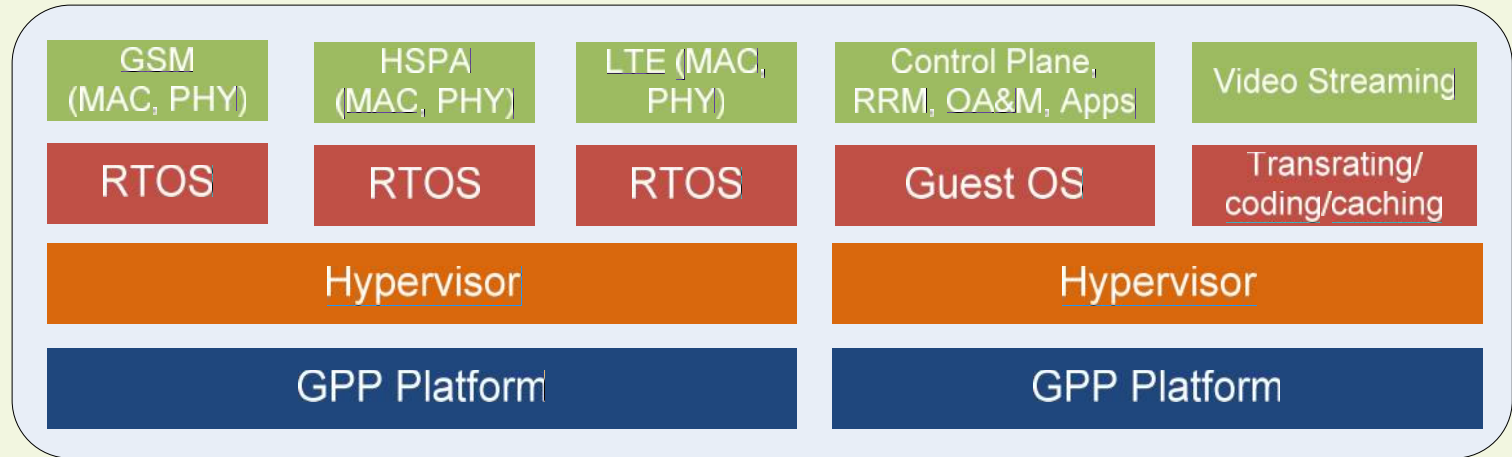


Aggregating baseband improves implementation of CoMP that enhances network performance

Baseband Virtualization



- › Migration to new technology
- › Base station consolidation
- › Applications at the edge



Decouple software from hardware

Benefits of Cloud RAN

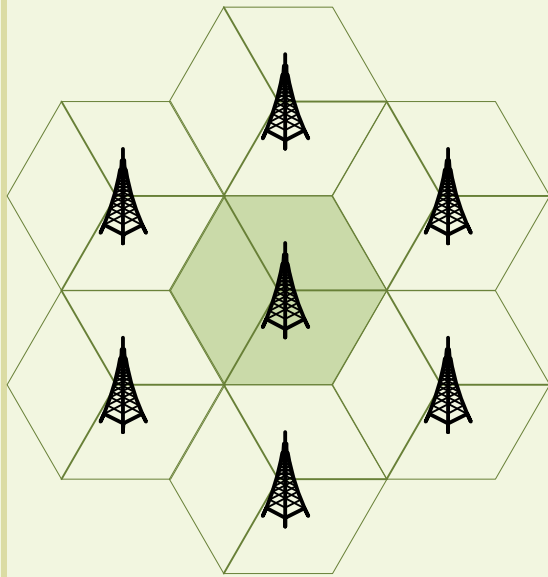
Pros

- Reduced cost
 - Operations & management
 - Energy savings (primarily HVAC)
 - Leasehold expenses
- Improved performance
 - Higher utilization of baseband resources
 - Lower interference
 - Higher capacity
- Simplified maintenance & upgradeability processes

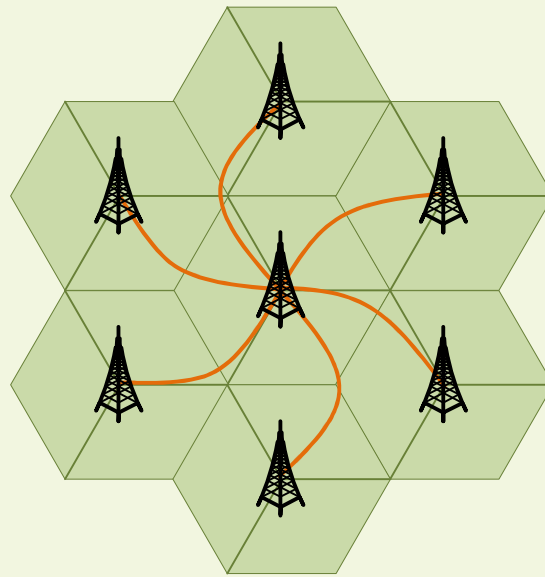
Cons

- Fiber availability & cost

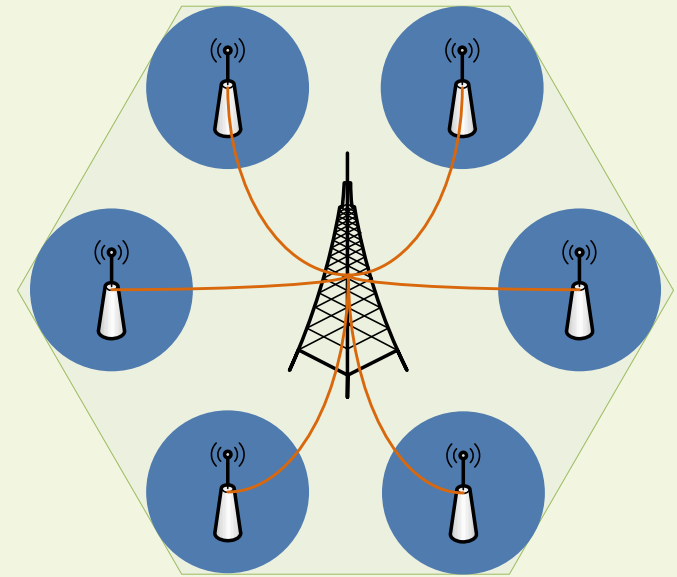
Cloud RAN Deployment Scenarios



Scenario 1
Homogeneous network
with intra-site CoMP



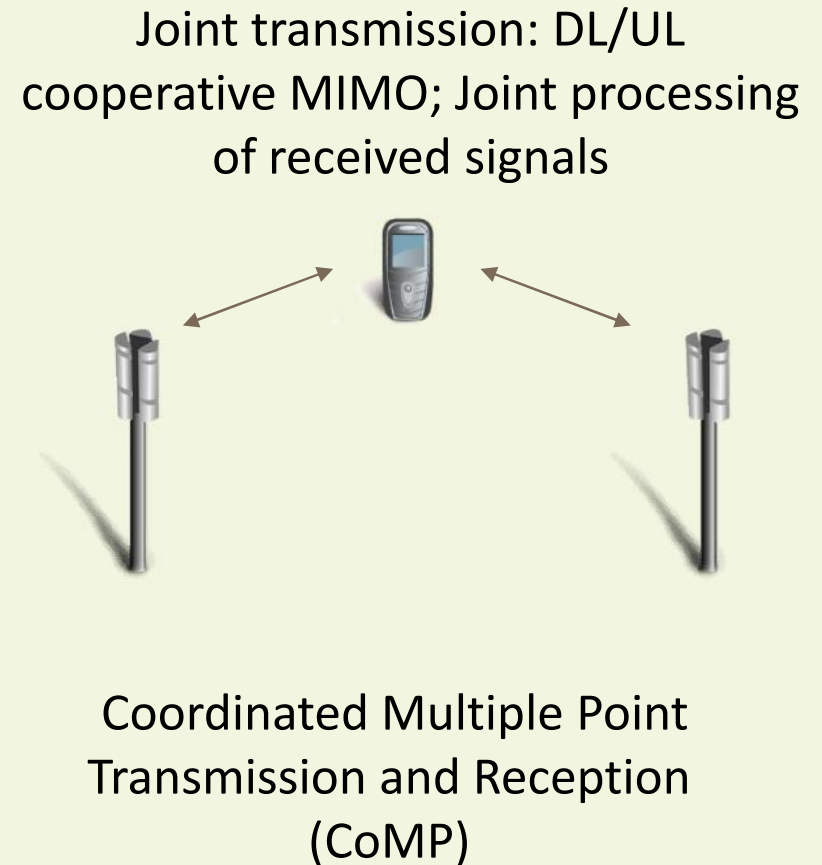
Scenario 2
Homogeneous network
with inter-site CoMP



Scenario 3
Heterogeneous
network with low power
RRHs within the
macrocell coverage

Coordinated Multipoint (CoMP)

- › Communication between mobile device and multiple geographically distributed base station antennas
- › Benefits
 - Improves cell edge performance
 - Improves average cell performance
 - Complementary to MIMO
 - Network MIMO
- › Requirements
 - Fast connectivity between base stations (X2): low latency & jitter



DL CoMP Performance in Macro Cells (FDD)

		Scenario 1 (1 cell cluster)		Scenario 2 (9 cell cluster)	
		X-Pol	ULA	X-Pol	ULA
Downlink CS/CB, SU MIMO 2x2	Cell Average	3.67%	5.15%	1.46%	4.03%
	Cell Edge	9.63%	11.64%	2.86%	4.42%
Downlink JT, MU MIMO 2x2	Cell Average	2.68%	12.68%	4.07%	13.53%
	Cell Edge	26.13%	36.68%	40.72%	40.5%
Uplink JR, SU MIMO 1x2	Cell Average	22.25%	12.15%	31.46%	13.90%
	Cell Edge	41.19%	22%	65.89%	32%

Note: Results are averages of simulations

ULA: Uniform linear array

X-Pol: Cross polarized antenna

For more data, see 3GPP TR 36.819

DL CoMP Performance (FDD) – HetNets (Scenario 3)

		CS/CB with eICIC	JP with eICIC	CS/CB without eICIC	JP without eICIC
Downlink	Macro cell area average	2.70%	3.30%	5.1%	3.0%
	5% Worst user	19.70%	52.80%	24.8%	24.1%
JR without eICIC					
Uplink JR, SU MIMO 1x2	Macro cell area average	13.5%			
	5% Worst user	39.70%			

Note: Results are averages of simulations
For more data, see 3GPP TR 36.819

CoMP Takeaways

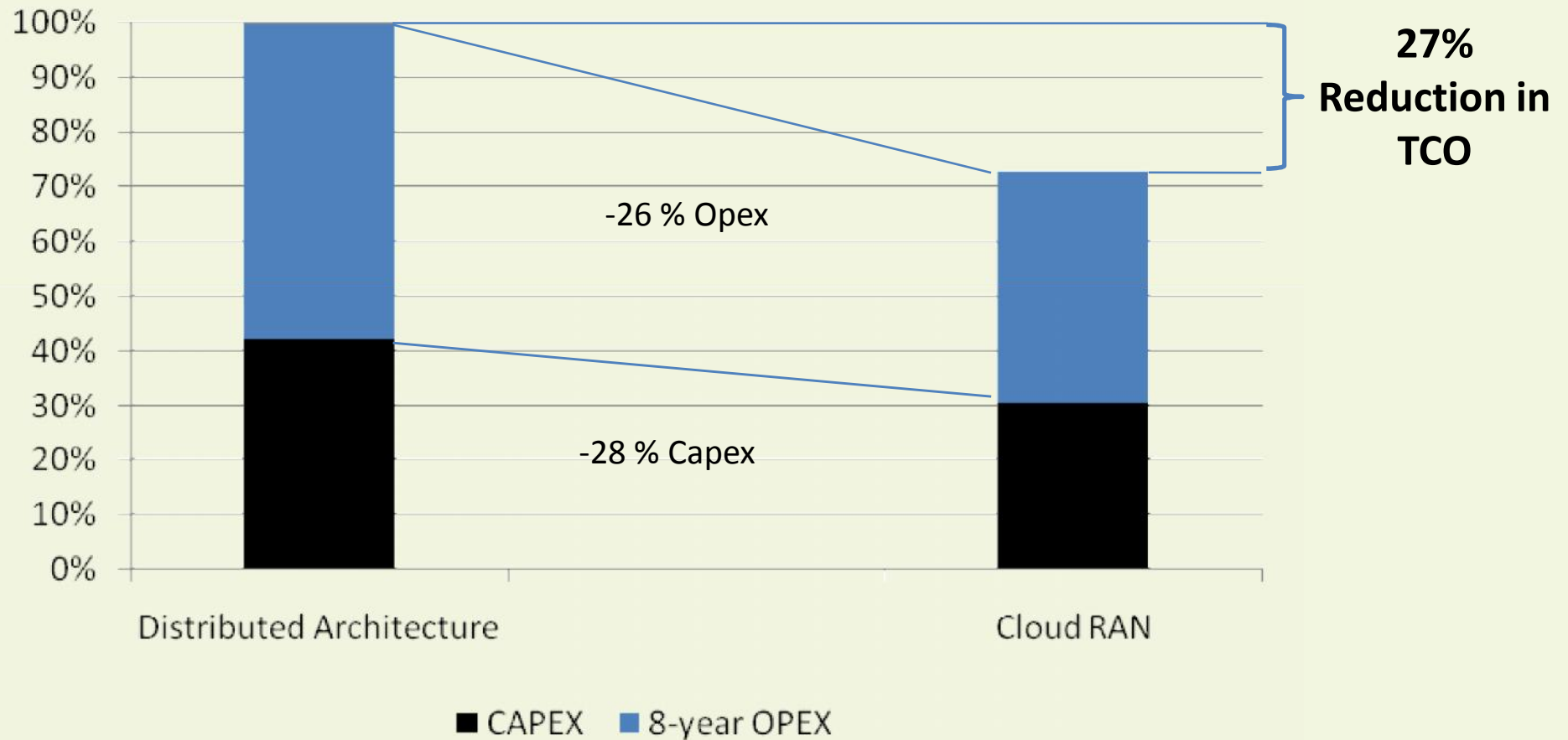
- › Greater benefits in HetNet scenario than macro cell deployment
- › Higher gain for cell edge user in comparison to cell-center users
- › Easier to implement in uplink than downlink
- › Higher gain possible in TDD than FDD networks
 - More sophisticated processing techniques possible in TDD

Performance improvement in CRAN will depend on network topology and operating mode

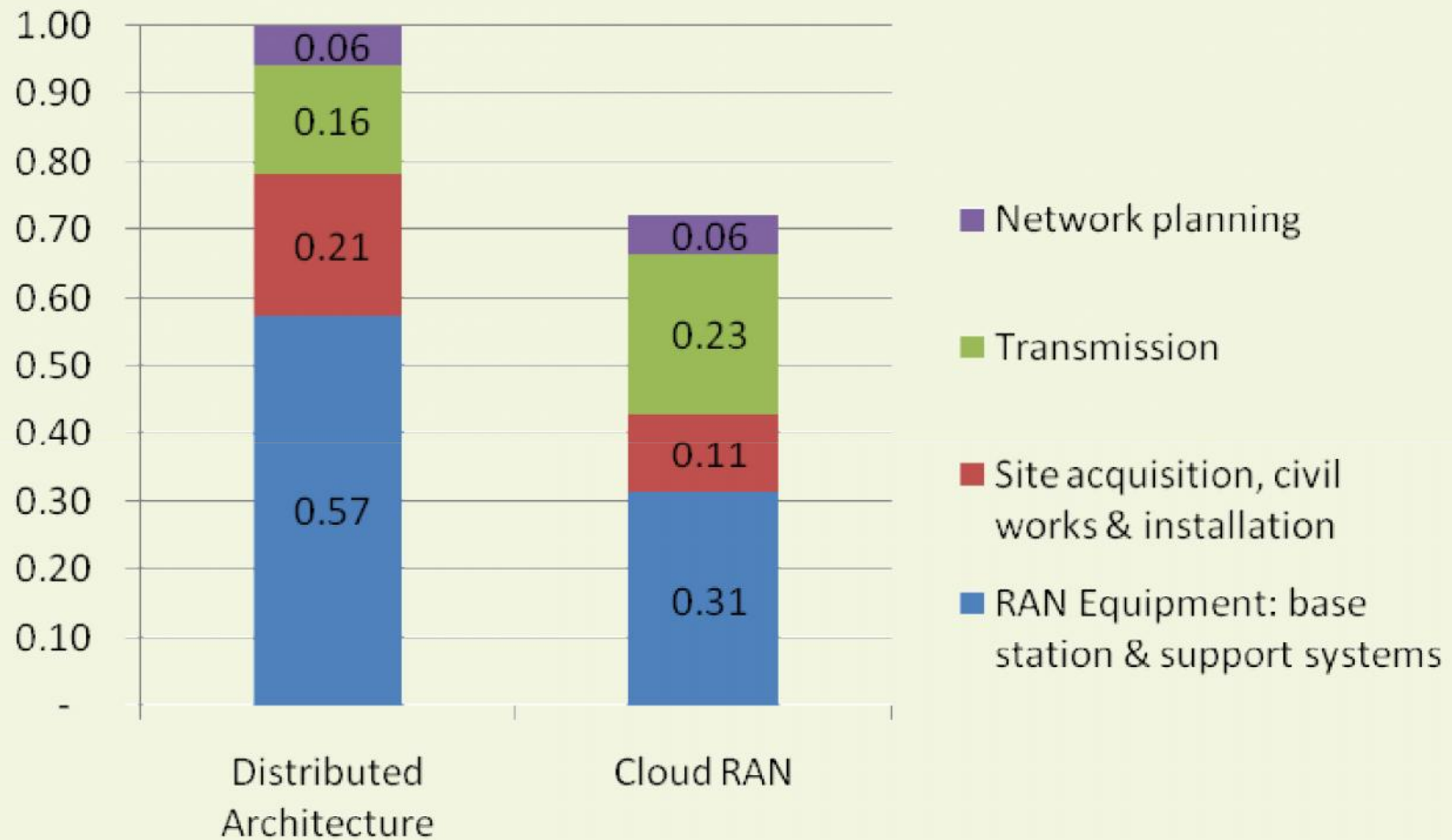
Case Study: Business Case for Asian Operator

- › Macro cell deployment
 - 3 sectored cell sites
- › Dark fiber is available to cell sites
 - PTP star topology from fiber center; 50 sites per center
- › TDD LTE (Config 1); 20 MHz channel; 4:1 DL/UL traffic ratio
 - 104 Mbps peak capacity; 27 Mbps average capacity
- › CoMP gain: 16% DL; 20% UL average cell area gain
- › Pooled & virtualized base station resources in data center

8-Year Total Cost of Ownership



Capex Analysis



Additional spend on fronthaul offset by reduction in site buildout and RAN equipment cost

Opex Analysis

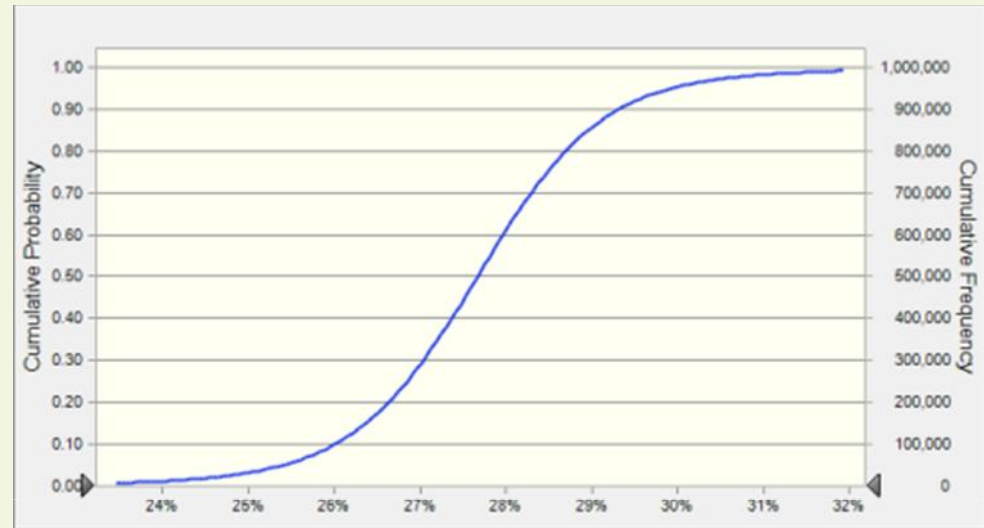


Reduction in energy, site rental and O&M costs

Statistical & Sensitivity Analysis

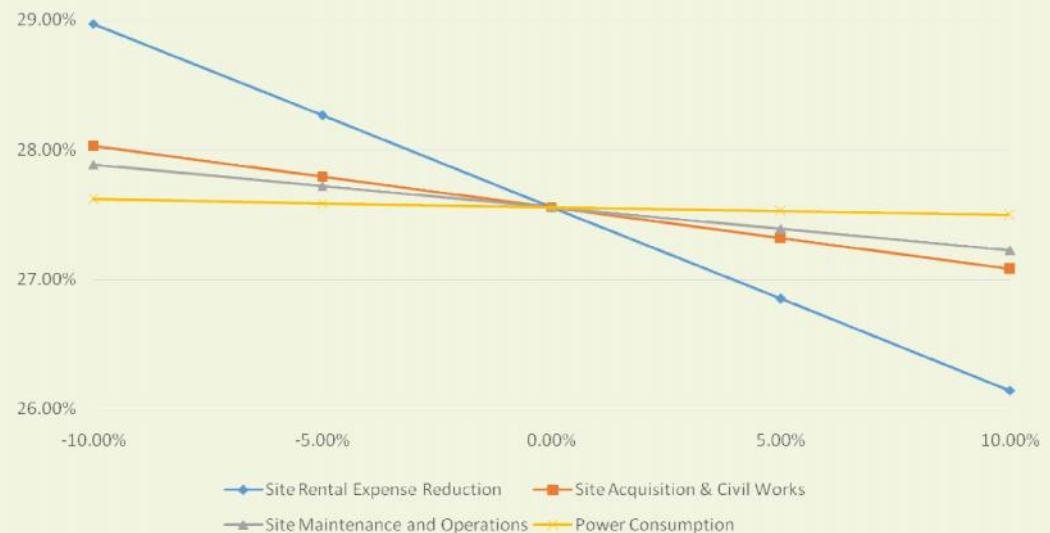
› Monte Carlo Analysis

- 2% std. deviation

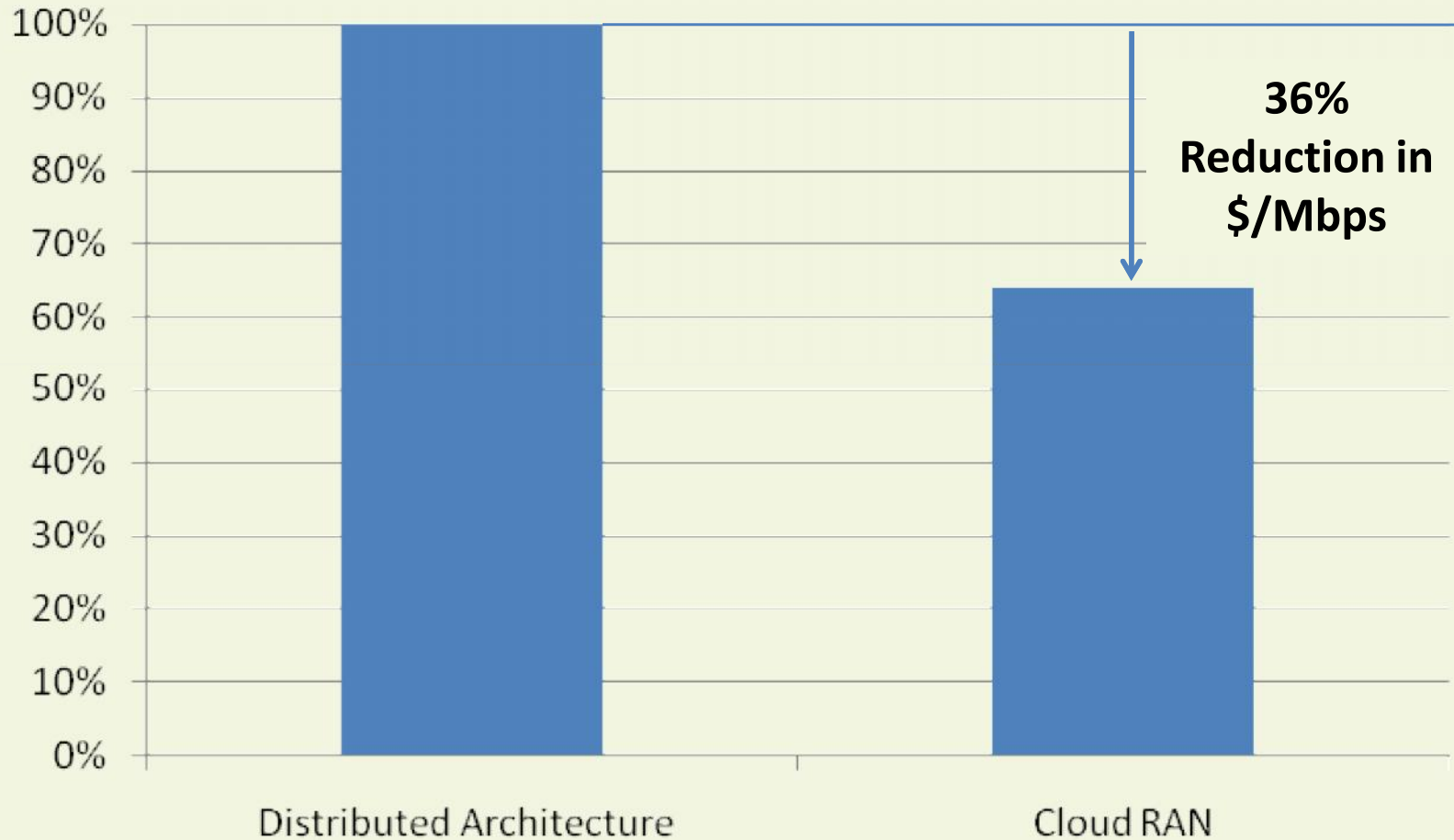


› Cost reduction drivers

- Site rental expense
- Site buildout
- Operation & maintenance
- Power consumption



Cost of Capacity (\$/Mbps)



A Word About Xona Partners

A Boutique Advisory Specialized in Technology Businesses
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- › Multi-layer technology expertise
 - Infrastructure, OS, application ecosystem business verticals
 - Telco, Cloud Migration/Data Center, Data Sciences focus
- › Services offering
 - New business incubation & growth strategies
 - Due diligence & lifecycle management
- › Published C-RAN market report in collaboration with Mobile Experts (Jan 2014)
 - Update to be released in Jan 2015



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