



Response to US Ignite

5G Network Addendum to Ft Carson 100% Submittal

2 JUNE 2020

PREPARED BY:

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Scott Turnbull and Team

Dear Mr Turnbull and team:

2 JUNE 2020

Puente Tilson JV, LLC is pleased to provide US Ignite with the attached addendum for an additional 5G option to the existing the wireless network design supporting the Ft Carson AV pilot program. Puente Tilson JV, LLC is a joint venture between Tilson Technology Management, Inc. and Puente Technology, LLC. Since 2007, Tilson has provided design, engineering, and construction services to many clients seeking to improve their infrastructure. We believe that we are well positioned to assist US Ignite with these services given our extensive experience and familiarity with the project objectives. Puente Technology is a Service-Disabled Veteran-Owned Small Business that provides a variety of construction management and IT services.

Tilson's extensive expertise in all manner of wireless deployments, technologies, and turnkey project execution provides the technical foundation for a seamless and successful project, while our partnership with Puente satisfies US Ignite's stated policy to comply with PL 99-661, Section 1207, regarding small business set-asides.

We thank you for your time in reviewing the addendum and we look forward to the possibility of working closely with US Ignite in the deployment of this project. If you have any questions regarding our design, please contact me at my direct line (207) 521-4106 or by email at jharding@tilsontech.com. We look forward to working on this project with you further.

Sincerely,

A handwritten signature in black ink that reads 'Jim D. Harding'. The signature is written in a cursive, flowing style.

Jim Harding
Engineering Manager

1.1 JMA LTE/CBRS Solution with 5G layer

Overview from JMA:

JMA's 4G Private LTE based solution can be upgraded to 5G via a software upgrade to their virtual base station called X-RAN. In addition to the 4G to 5G upgrade JMA is currently working with carriers and other industry leaders to develop an open standard based solution for fronthaul called ORAN or 7-2x. The purpose of this capability is to move off the current CPRI proprietary based fronthaul solution to one that is more efficient. It also includes open-based standards so that customers can mix and match best of breed technology between base stations and remotes. JMA expects the 7-2x and 5G capabilities to be ready for deployment toward the end of the year. They have built into the proposal funding to drive both a 4G to 5G upgrade as well as the support to upgrade for ORAN which may include upgrading the Cell Hub remotes.

Additional cost for JMA 5G add-on to existing design - **\$250,700**

Total cost for JMA 4G/5G hardware solution: **\$468,700**

1.2 Nokia LTE/CBRS Solution with 5G layer

Overview from Nokia:

NOKIA follows the 3GPP standard for deploying a Non-Standalone 5G (NSA 5G) architecture which uses the 4G as the control plane and 5G as the data plane. This architecture is what most carriers are rolling out as it leverages the existing 4G infrastructure to quickly offer 5G. NOKIA also has the AirScale BBU sub-rack that supports 5G in one half and 4G LTE on the other half. This configuration is unique to Nokia.

NOKIA's 5G solution add-on will require additional 5G hardware installed at each 4G node location to provide both 4G and 5G functionality. This requires two times the number of remote radios and antennas per pole per Nokia's design. This cost includes the 5G software upgrade and the hardware cost of remote radio heads (RRH's). Any additional installation costs incurred are itemized in the installation/labor table.

Additional cost for Nokia 5G add-on to existing design **\$1.2MM**

Total cost for Nokia 4G/5G hardware solution: **\$1.7MM**

1.3 Ericsson LTE/CBRS Solution with 5G layer

Overview from Ericsson:

Ericsson is an OEM and telecommunication solutions provider founded in 1876 with a long history of research, development that covers over 54,000 patents and system deployments in over 180 countries. Ericsson spends over \$3B USD yearly in research and development focused on advancements of wireless technology. Participates in most of the 3rd Generation Partnership Project (3GPP) specification groups to develop open standards for cellular equipment. Ericsson is the chair on the Radio Access Network 3GPP Working Group, Chairs the CBRS Alliance Technical Working Group and has invested \$1B in a smart-manufacturing facility in Lewisville, TX to address secure supply chain concerns of the Government. Ericsson's 5G network technology is implemented in every Tier 1 wireless operator in North America.

The 4G/5G solution Ericsson is offering is a standards based 3GPP compliant RAN and Core network. Ericsson's Radios are 4G/5G capable and only require SW upgrade to migrate from 4G/5G as well Ericsson has develop Ericsson Spectrum Sharing functionality allowing Radios to operate in the same frequency for both 4G/5G.

Program efficiency and risk reduction will be achieved by using Ericsson's proven 4G/5G RAN/Core and allow the program to focus on use cases and applications not the underlying communication network.

Ericsson was a late addition to pricing and was not included in the original 4G estimate, so there is no delta to show between a separate 4G and 5G solution. The solution does require 2 separate radios for each technology on each estimated pole, effectively doubling labor costs at the pole from previous 4G-only estimates.

Total cost for Ericsson 4G/5G hardware solution: **\$2.5MM**

2 Puente Tilson Installation Cost Proposal

Costs for pole installations are budgetary due to unconfirmed power and fiber availability and variable pole pricing:

Item	Desc.	Cost	Qty	Extended Cost
Utility Pole	Class 3 25' AGL	\$2,500.00	1	\$ 2,500.00
Utility Pole	Class 3 30' AGL	\$2,500.00	4	\$ 10,000.00
Utility Pole	Class 3 35' AGL	\$3,000.00	1	\$ 3,000.00
Utility Pole	Class 3 40' AGL	\$3,500.00	2	\$ 7,000.00
Utility Pole	Class 3 45' AGL	\$4,000.00	2	\$ 8,000.00
Node/Sector installation	Pole mount equipment, optimize sector (Both CBRS and 5G installs)	\$4,000.00	20	\$ 80,000.00
Power	Connect pole to commercial power	\$2,500.00	10	\$ 25,000.00
Fiber	Trench or horizontal bore from termination to pole	\$35/ft		Unknown
Fiber	Pull, install and splice/terminate fiber (including materials and handhole)	\$2,750.00	10	\$ 27,500.00
	Total Cost to deploy			\$ 163,000.00

Puente Tilson JV has taken every opportunity to ensure a conservative, robust RF design. As an industry best practice during actual pole deployments, each route will be tested on-site for coverage from a CW at elevation prior to pole placement to ensure only what is needed for coverage is deployed. As such, the actual number of poles and installations may vary slightly in either direction. With the increased number of radios required at each location for the 5G addition, radio installation costs necessarily double per pole. Other associated costs should remain the same or reasonably close to estimated pricing.

2.1 Addendum, Cost Estimates for 5G Upgrade

The following table details cost estimates for upgrade to the original JMA Solution presented in Appendix A – Ft. Carson Wireless Testbed Design, sections 3.3.2.1 and 6.2.

Table 2.2

LTE RAN Sites	Sites	Radio Hardware	Radio Software	Cabinet and Site Material	Engineering Integration Services	Total
1 sector sites	7	\$ 198,072	\$ 118,557	\$ 67,911	\$ 80,500	\$465,047
2 sector sites	2	\$ 78,517	\$ 67,747	\$ 23,189	\$ 23,000	\$192,455
3 sector sites	3	\$ 150,663	\$ 152,431	\$ 26,248	\$ 34,500	\$363,845
5G Add-on	Sites	Radio Hardware	Radio Software	Cabinet and Site Material	Services	Total
1 sector sites	7	\$ 53,244	\$ 55,720	\$ 379	\$ 80,500	\$189,843
2 sector sites	2	\$ 30,425	\$ 31,840	\$ 1,515	\$ 23,000	\$ 86,780
3 sector sites	3	\$ 68,456	\$ 71,641	\$ 3,409	\$ 34,500	\$178,006
NSA -EPC Core	Sites	Core Hardware	Core Software	Site router	Services	Total
	1	\$ 23,421	\$ 92,138	\$ 3,602	\$ 142,121	\$261,283
Ericsson Network Manager and Domain Proxy	Sites	Network Manager Hardware	ENM Software	Domain Proxy Software	Services	Total
	1	\$ 111,034	\$ 65,168	\$ 37,778	\$ 251,234	\$465,214
Support Services	Customer Support	SWUpdate Services				
CBRS Solution	\$ 131,895	\$ 80,073				
5G Add-On	\$ 91,918	\$ 23,880.210				