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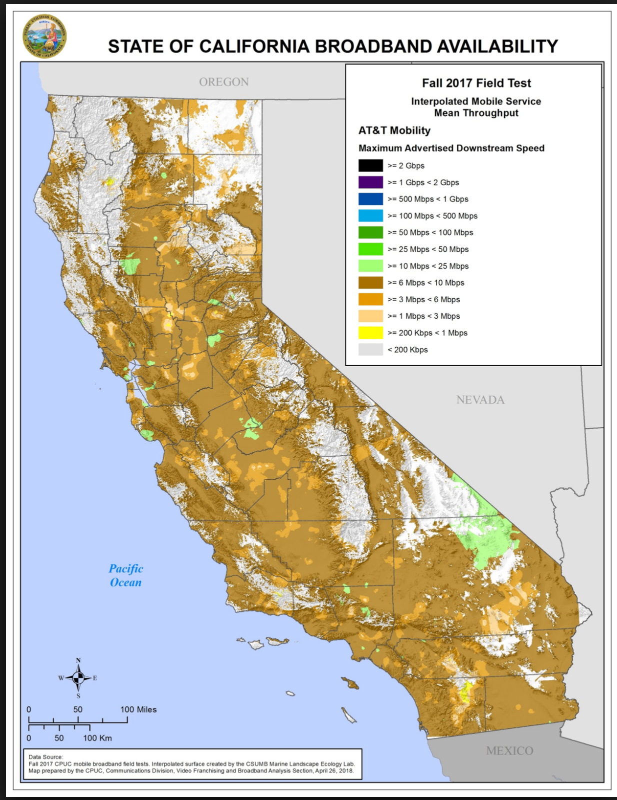
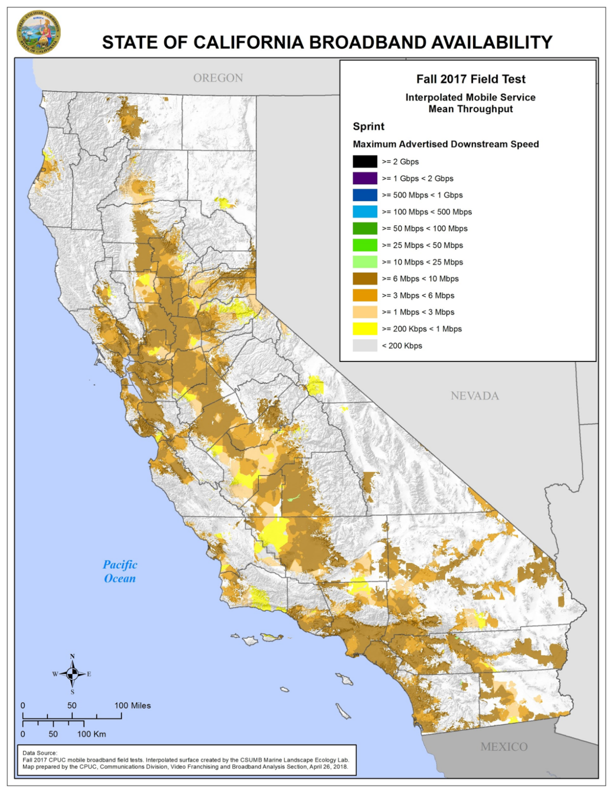
AUGUST 2018

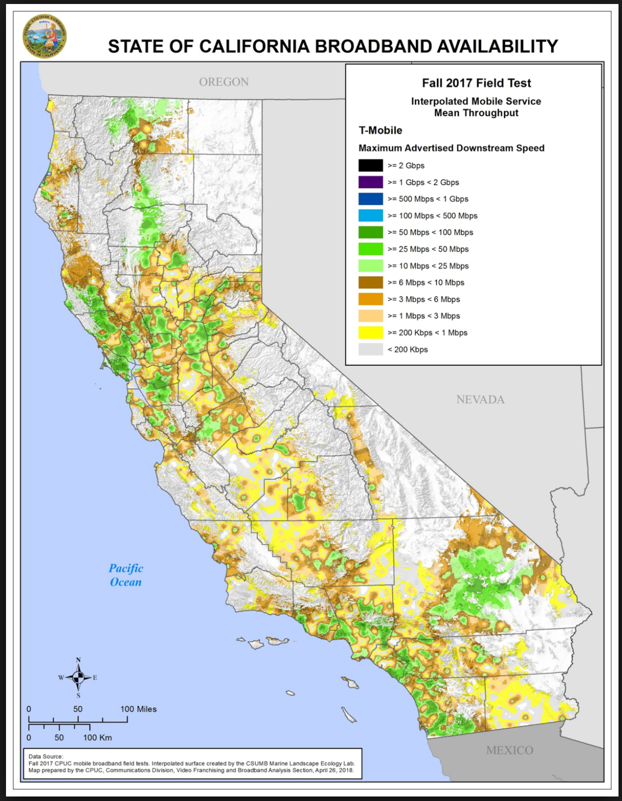
CALSPEED – CALIFORNIA'S BROADBAND ASSESSMENT

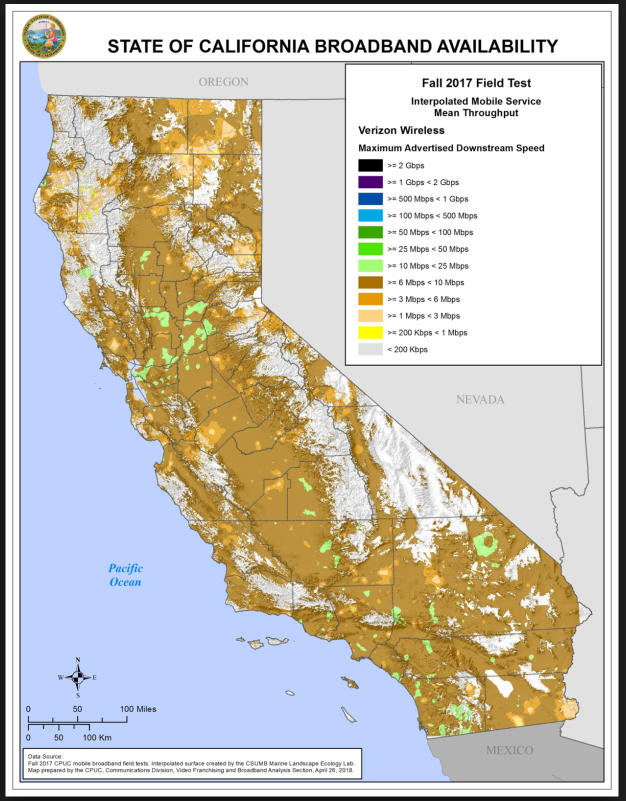
BROADBAND KEY CALIFORNIA ASSET

- Astonishingly poor information
- Carriers Perceived Less Than Transparent
- California Broadband Measurement
  - Bootstrapped by NTIA grant in 2011
  - Now funded by California Assembly
  - Managed by California Public Utility Commission
    - Novarum (design, analysis)
    - CalState U @ Monterey Bay (tools, mapping)
    - CalState U @ Chico (mapping, operations)
- User Experience
  - Urban, rural, tribal, no service, underserved
- Open Source: Tools + Data
- Mobile Broadband First
- End-to-end User Experience
  - Content all across the Internet
- Maps/information for decision makers
  - Consumers
  - Government
  - Advanced geostatistical interpolation techniques to translate raw measurements into geographic information
- Inform California Advanced Services Fund (CASF)



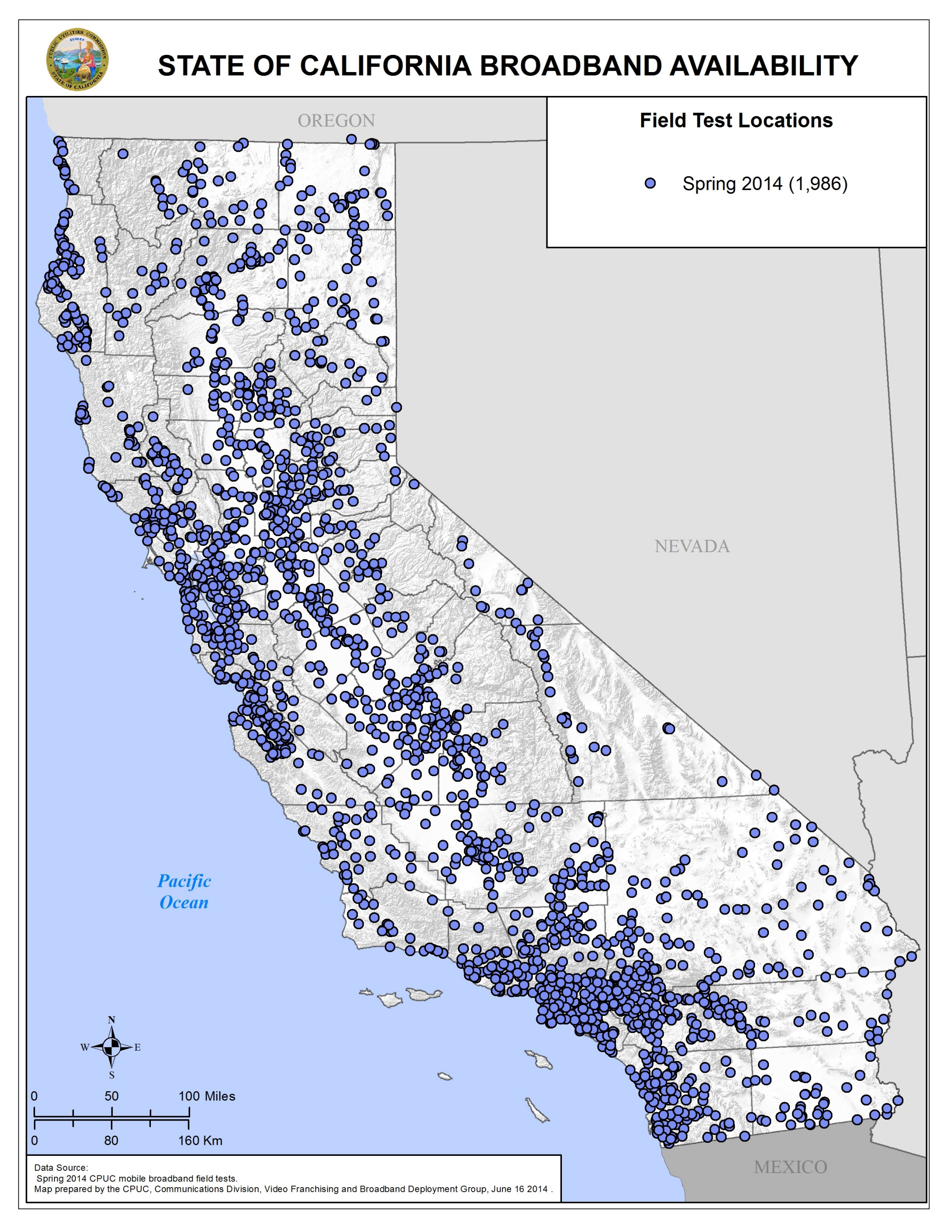






METHODOLOGY

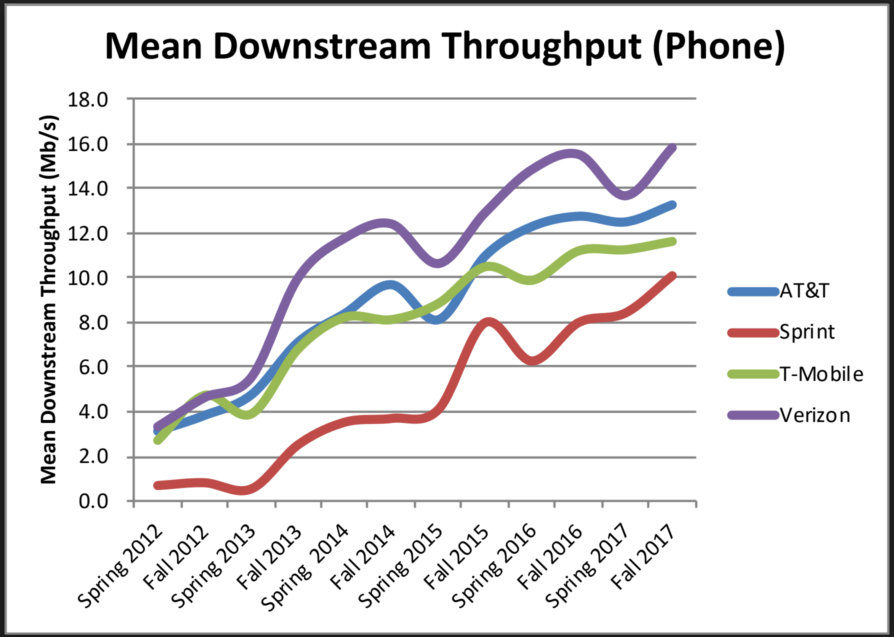
- Open Source Network Measurement
  - Based on industry standard open source tools (iPerf)
  - Android, iOS, desktop, web
- End-to-end User Experience
  - Both near (San Jose) and far (Virginia) measurement servers in AWS
  - Organic metrics
    - Upstream and downstream TCP throughput
    - Latency
    - Packet loss
    - Jitter
  - Synthetic metrics
    - Mean: average of near and far
    - VoIP quality - "VoLTE over IP"ish
    - Video quality - "Googlish"
- Sampling vs Crowd Sourced
  - 95% of California has no crowds
  - Explicit survey in 1,986 locations throughout California
    - Urban, rural, tribal within carrier asserted coverage
  - Repeated at the same location with same measurement at periodic intervals (~2,000,000 measurements/survey)
  - Complemented by crowd sourced version
  - Complemented by "zoom" surveys
- Multiple devices
  - Smartphones, tablets, laptop
- Just the facts
  - No filtering of measurements

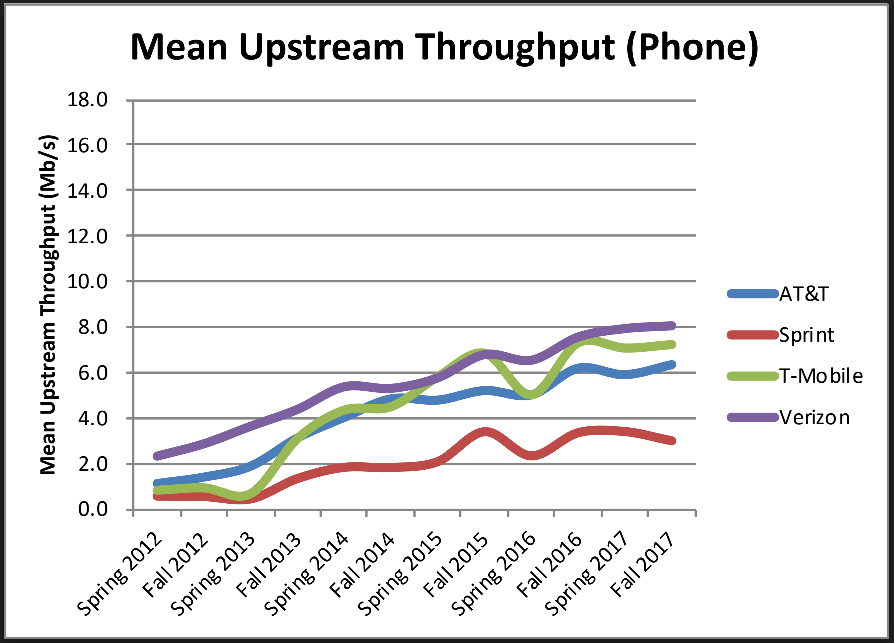


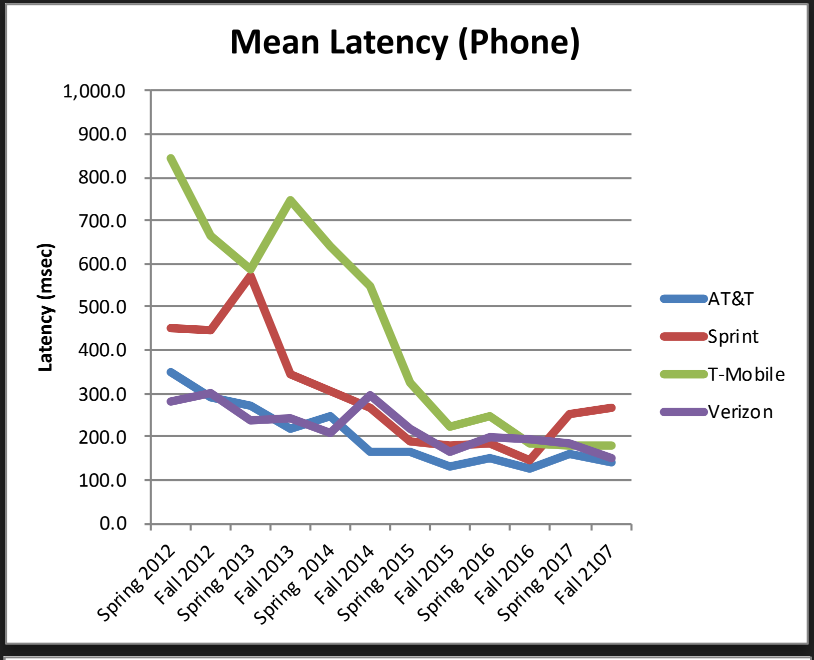
KEY THEMES

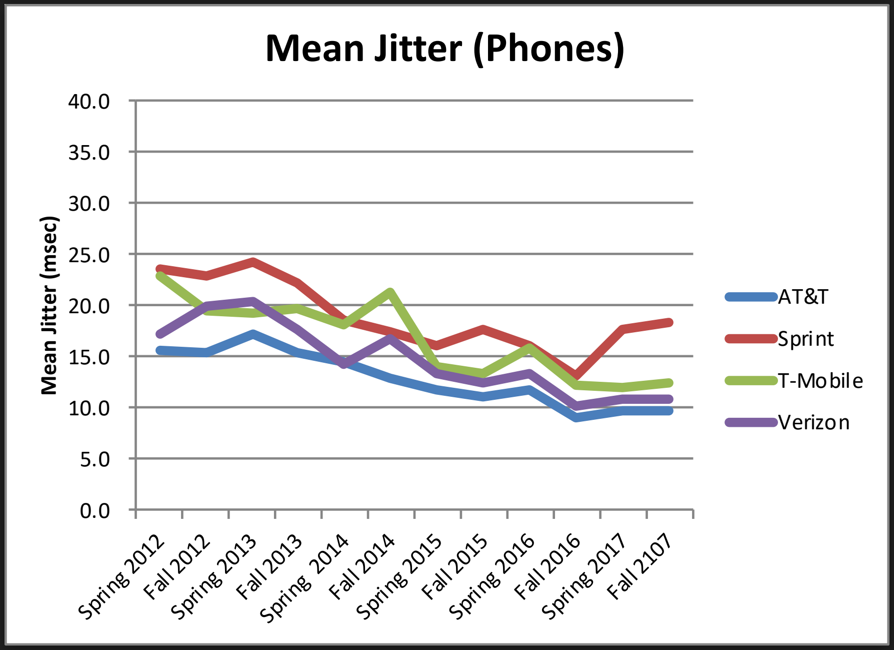
- Wide variation in quality and coverage
- Overall quality improving …. but …
- Not all carriers are equal
- Not all user devices are equal
- Location matters: users and content
- Rural/tribal users are 3/5ths of an urban user
- Challenges for mission critical applications
    - Public safety

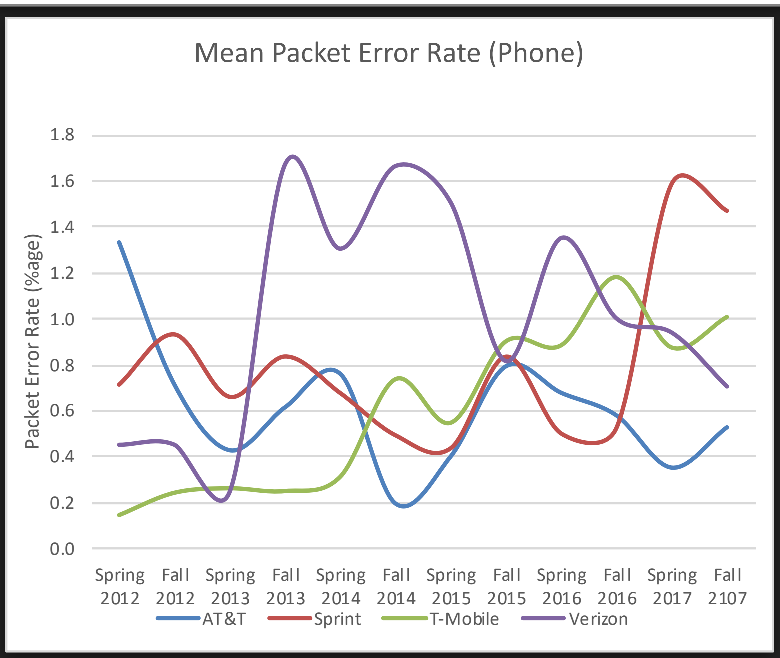
OVERALL QUALITY TRENDS

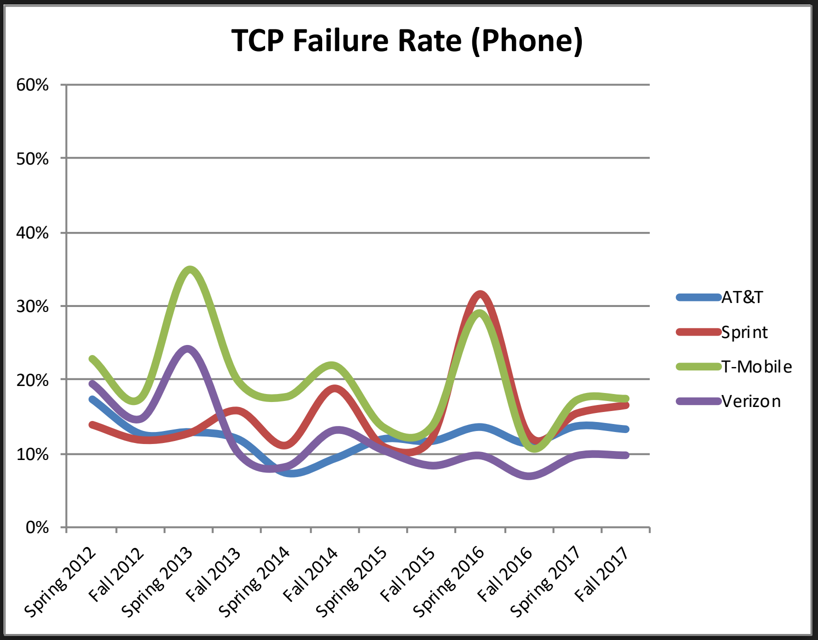






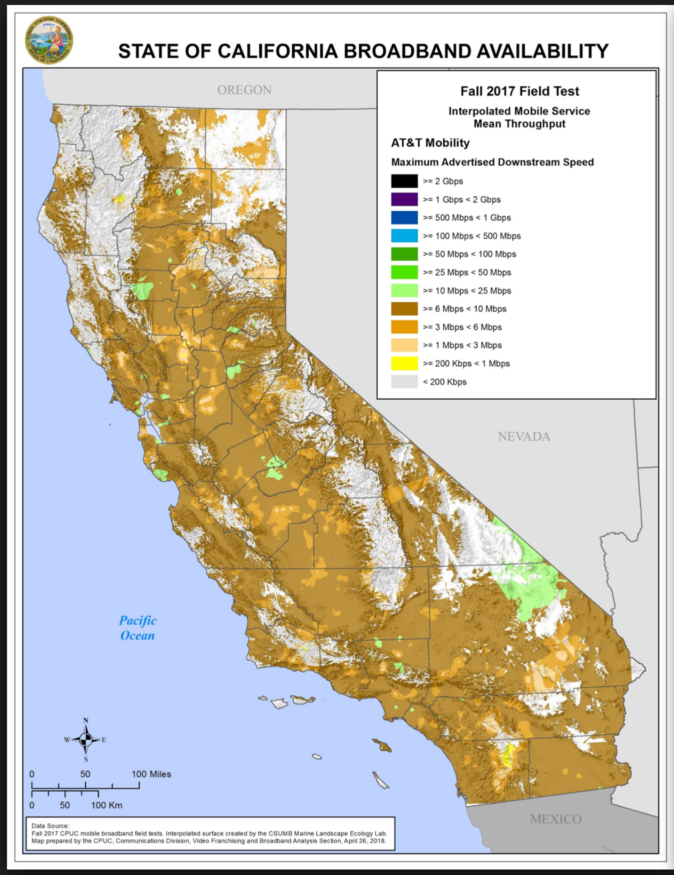


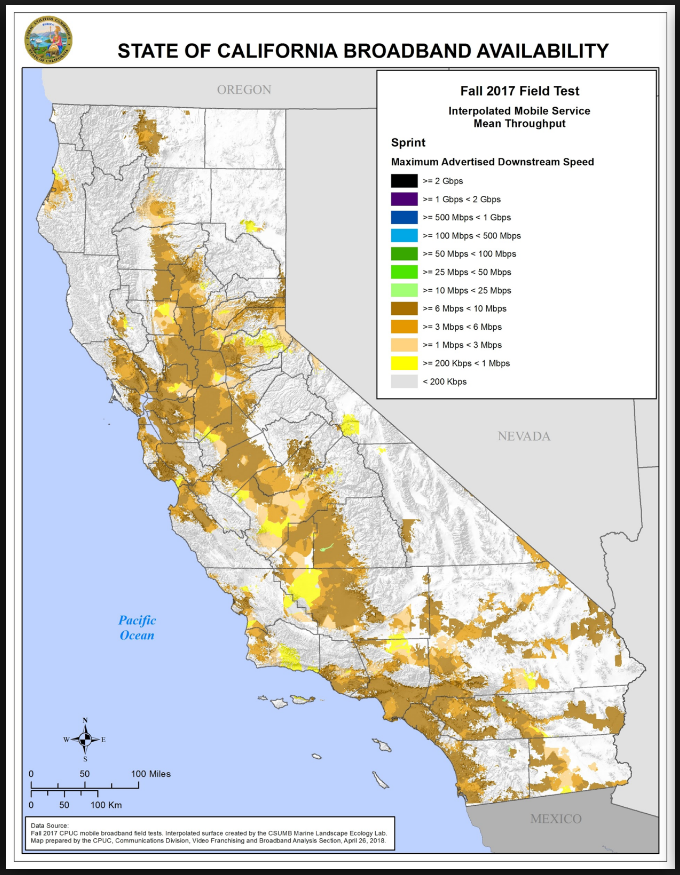


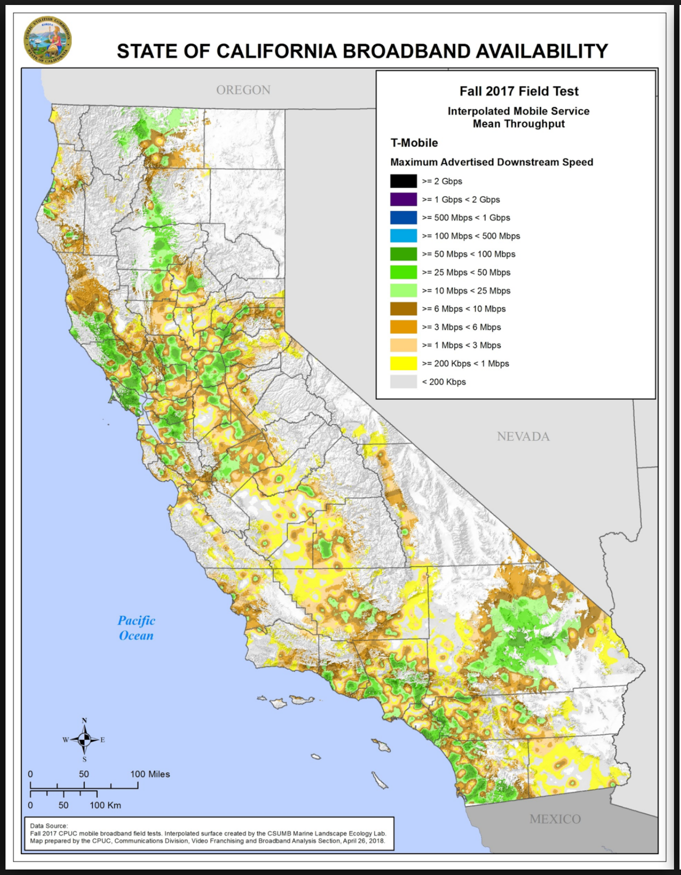


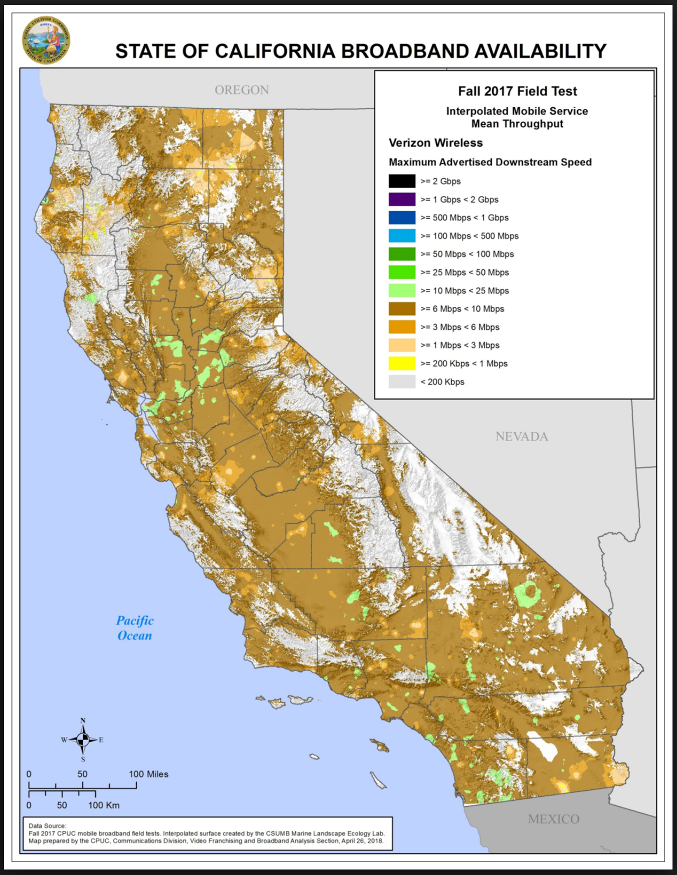
LOCATION MATTERS: WHERE THE USER IS

MEAN DOWNSTREAM TCP



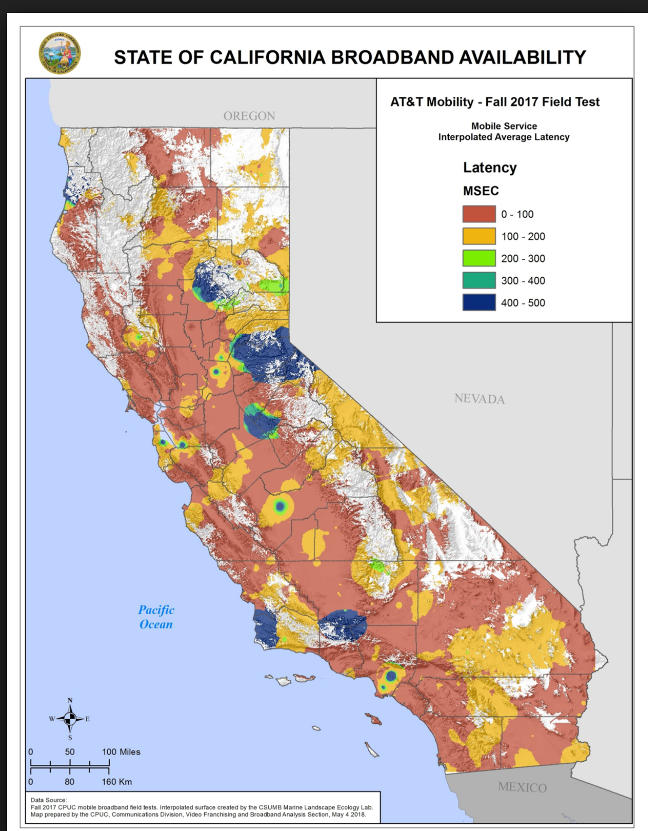


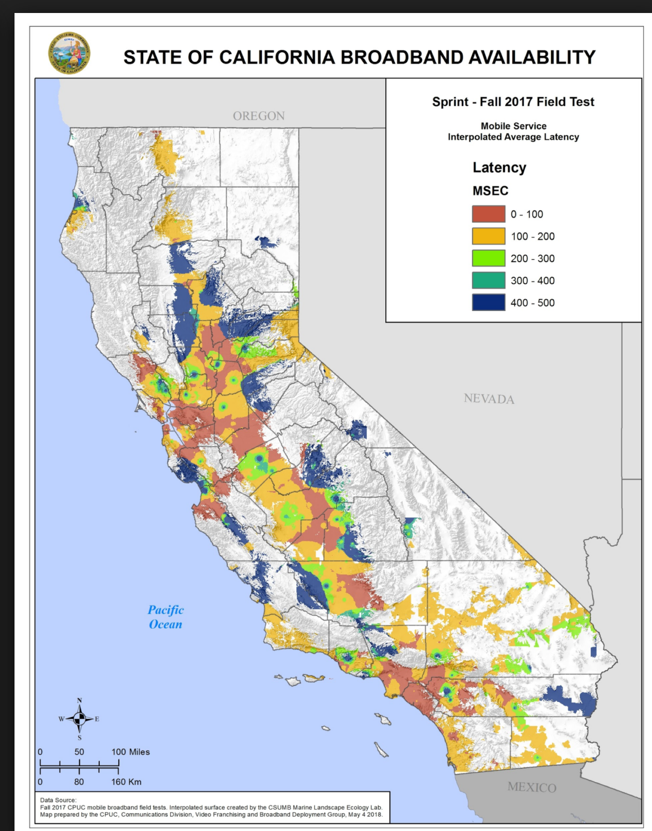


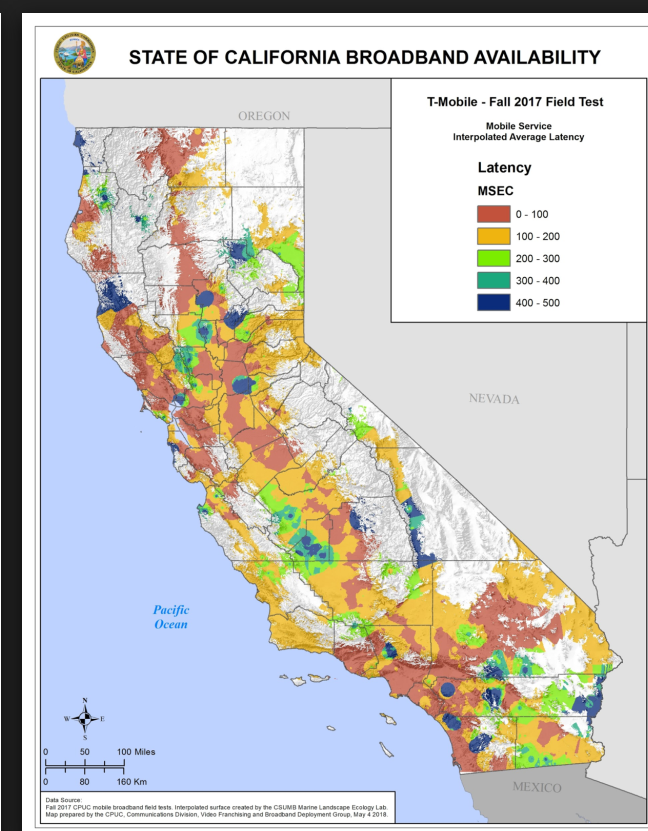


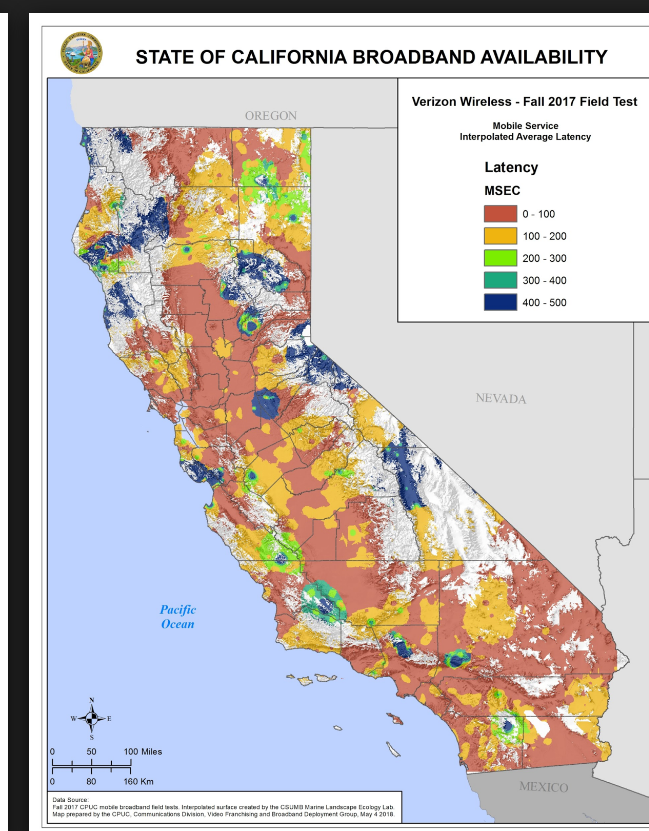
LOCATION MATTERS: WHERE THE USER IS

MEAN LATENCY



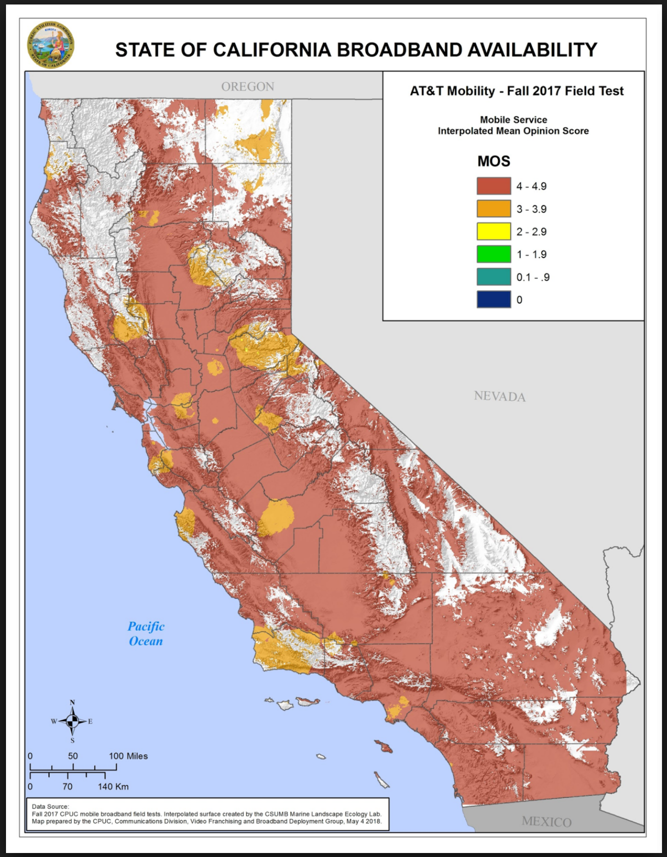


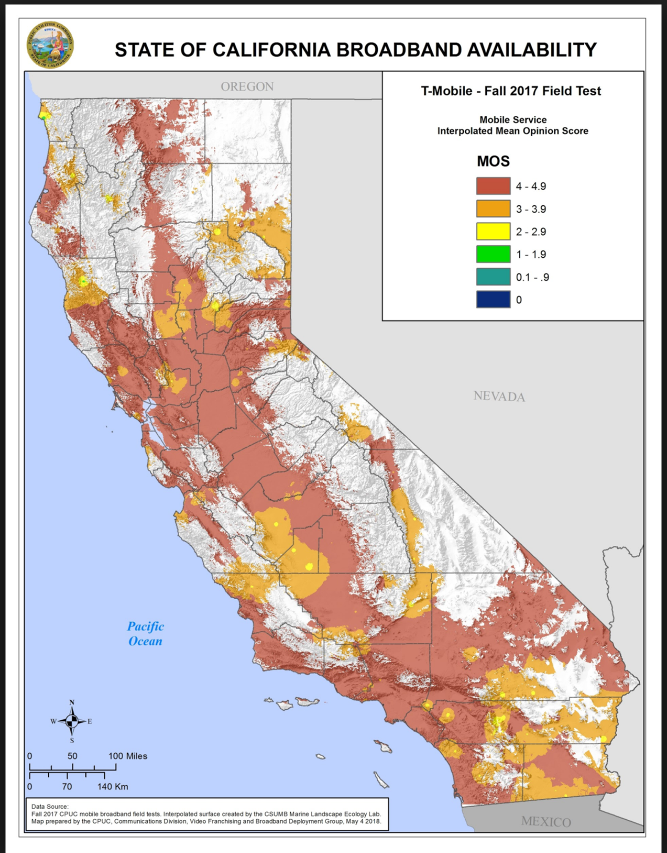


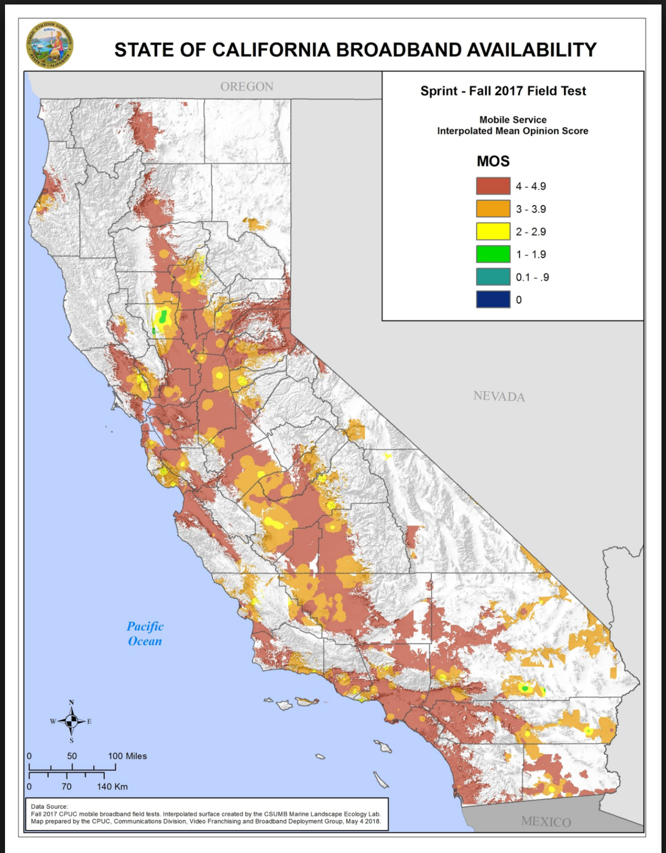


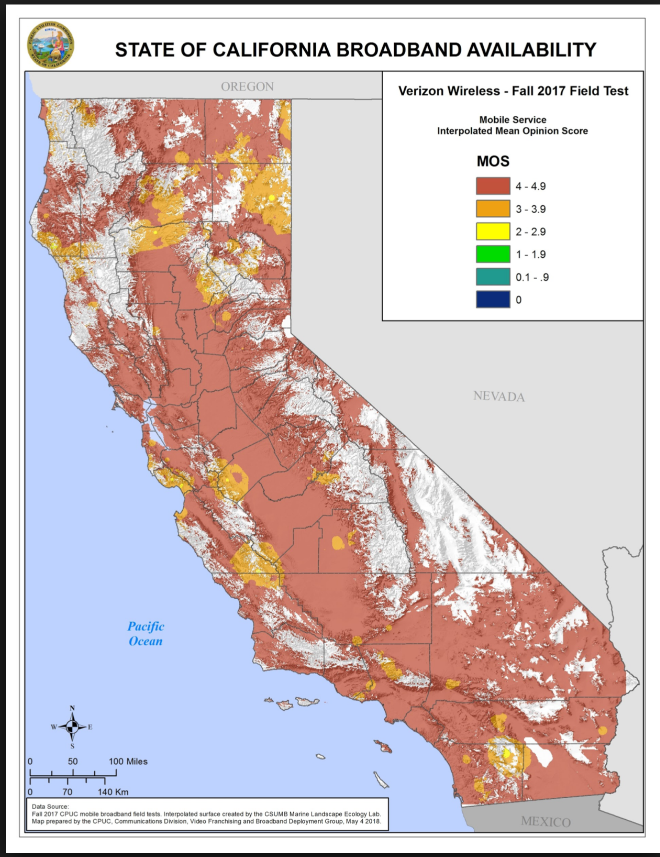
LOCATION MATTERS: WHERE THE USER IS

VOIP MOS

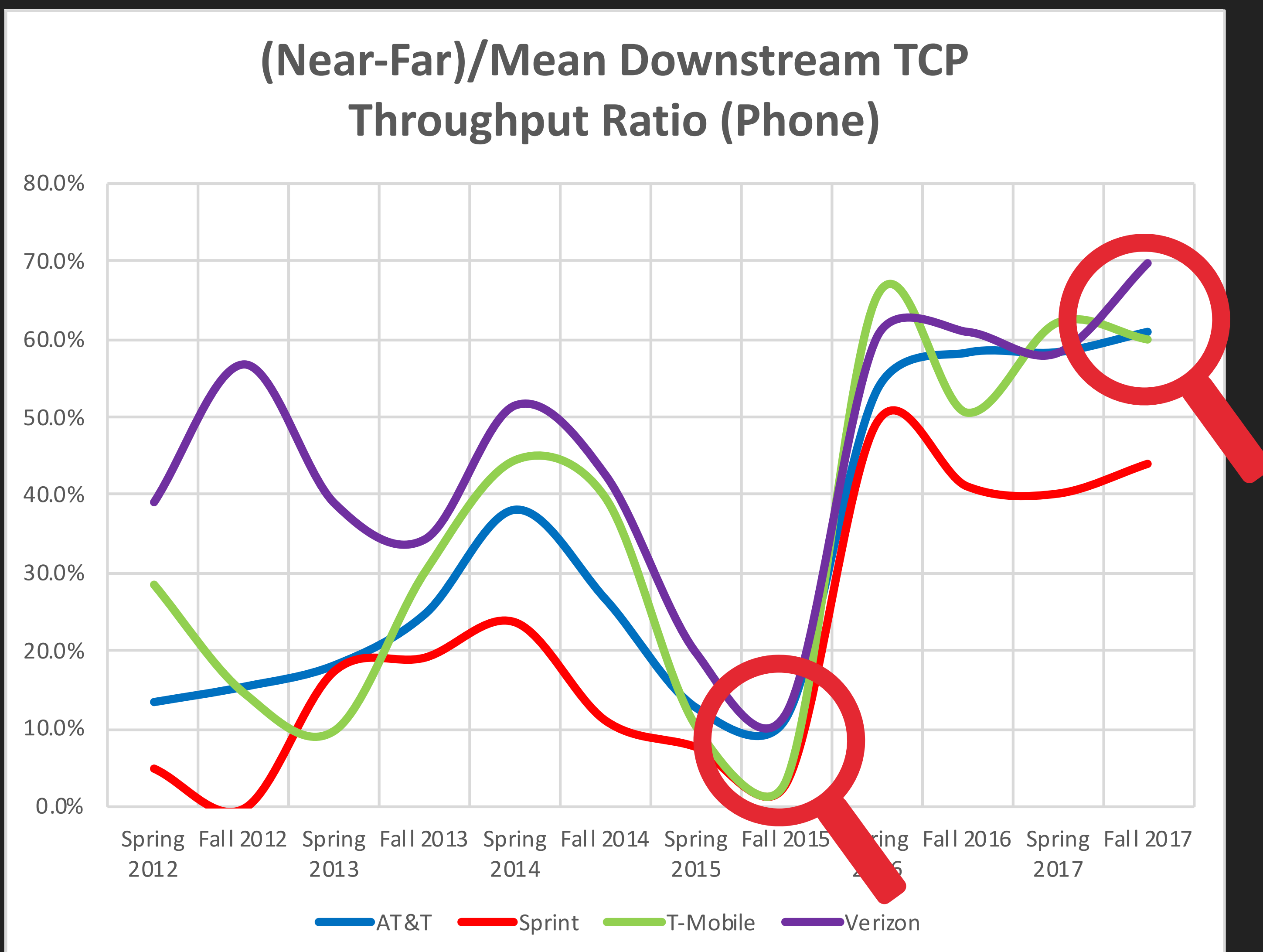


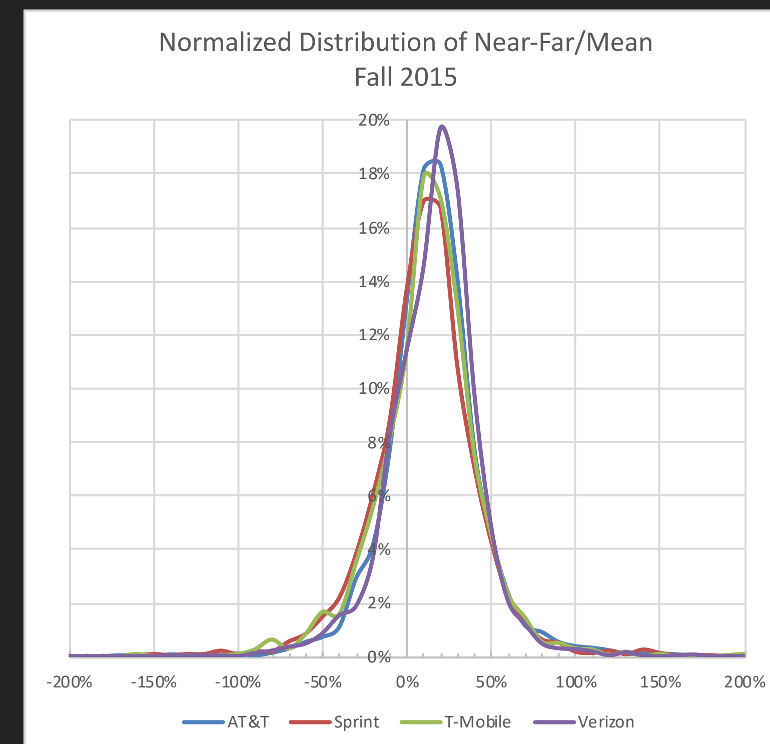


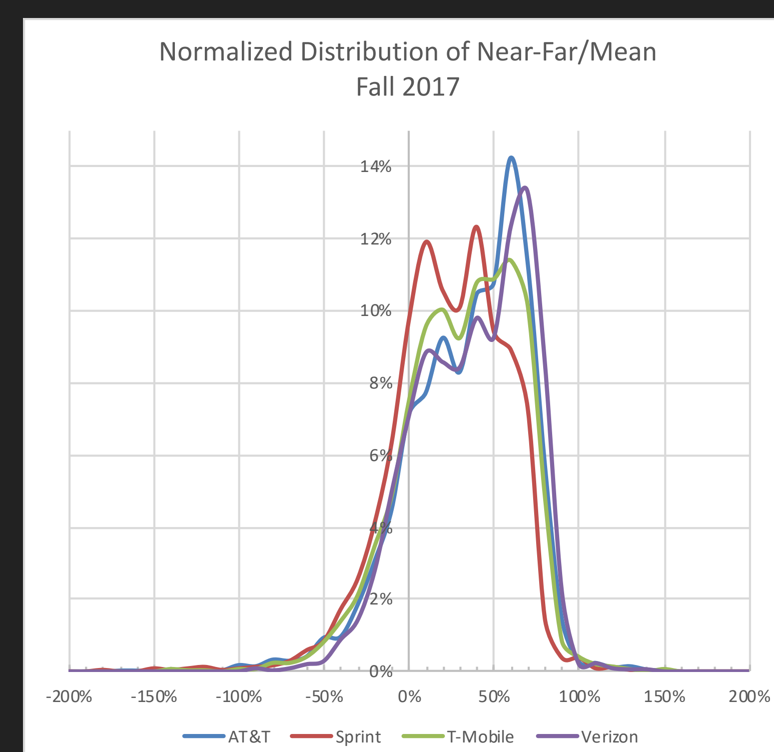




LOCATION MATTERS: WHERE THE CONTENT IS







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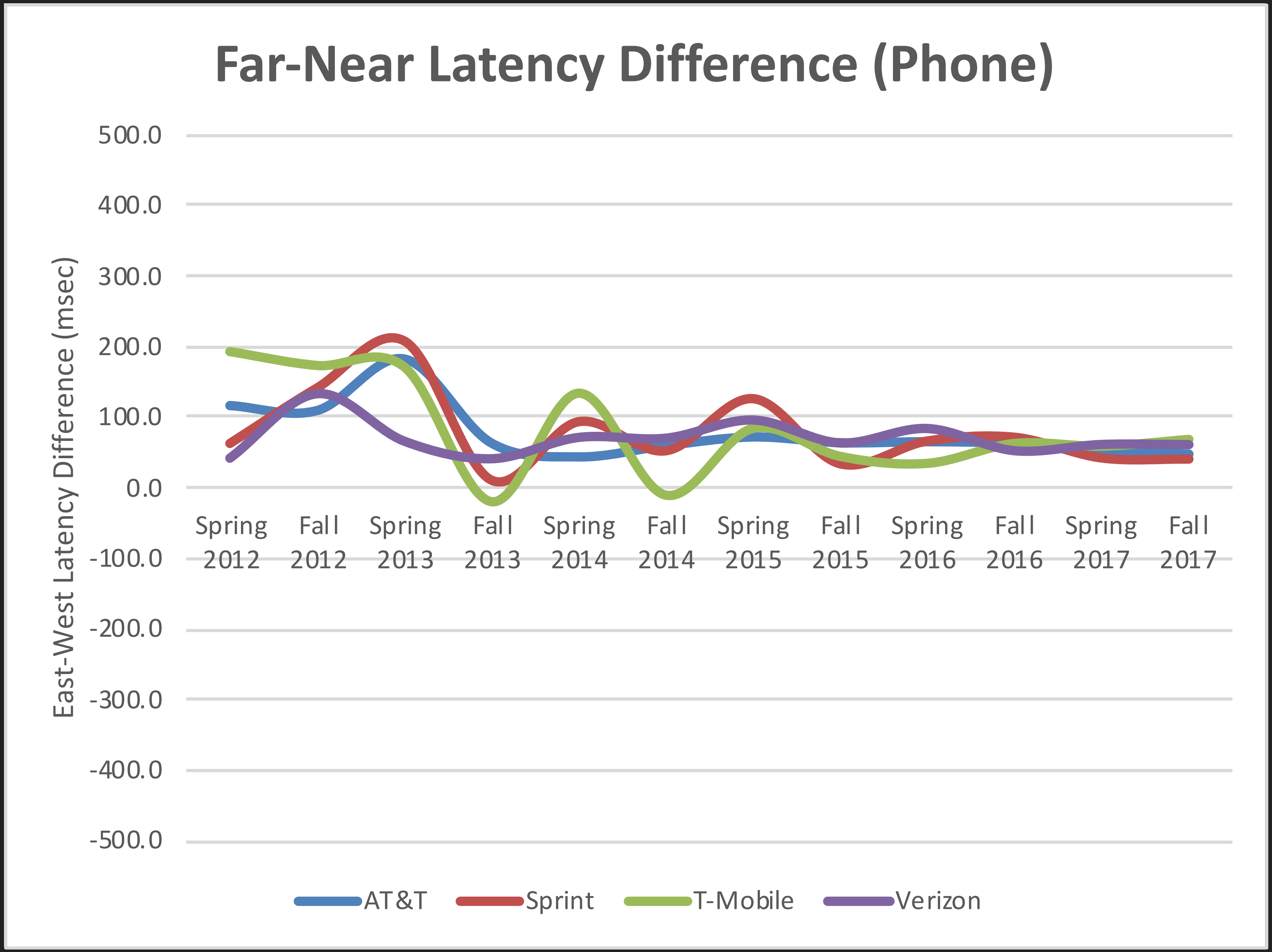
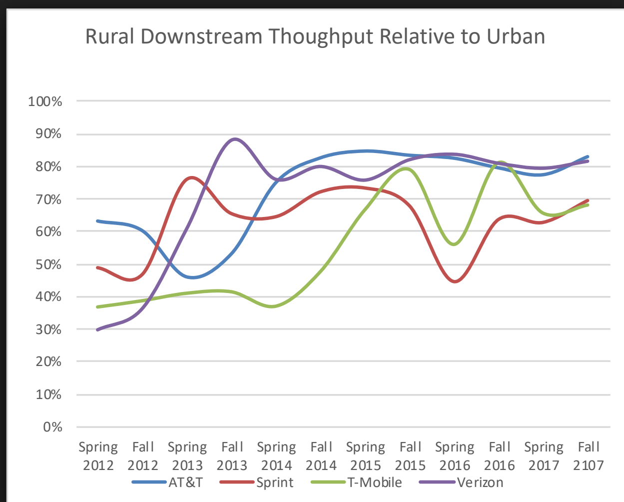
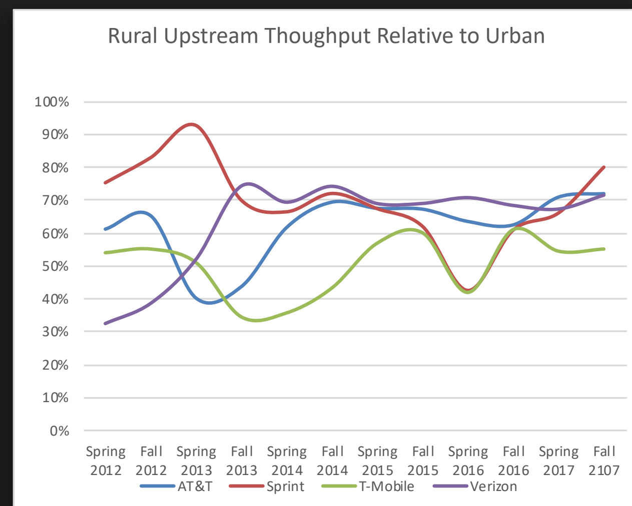


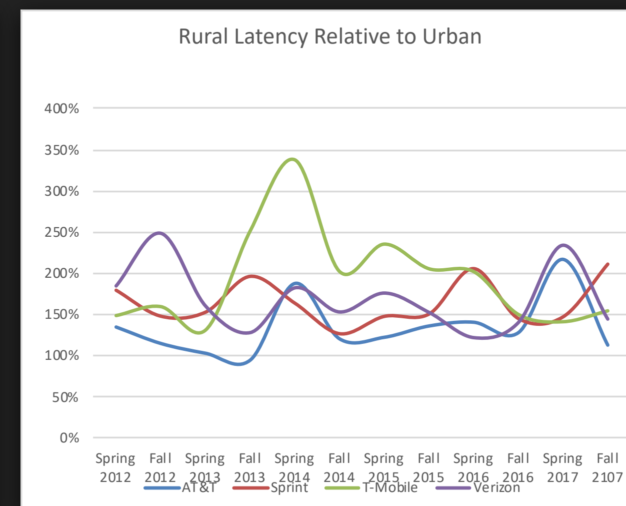
RURAL CALIFORNIA

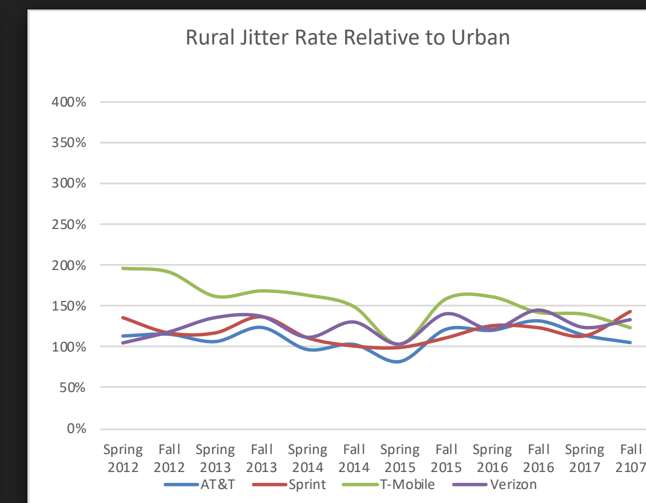
- 13% of California's population
- 95% of California's land
- 17% of US agricultural production
- ~100% of California tribal lands

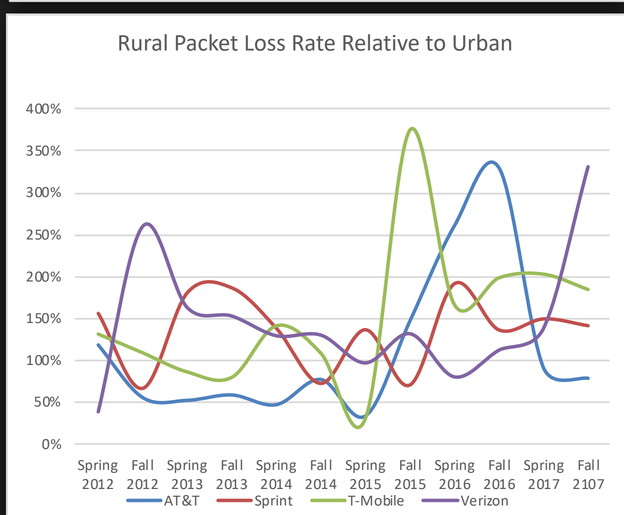
RURAL/TRIBAL USER “3/5THS” OF URBAN USER

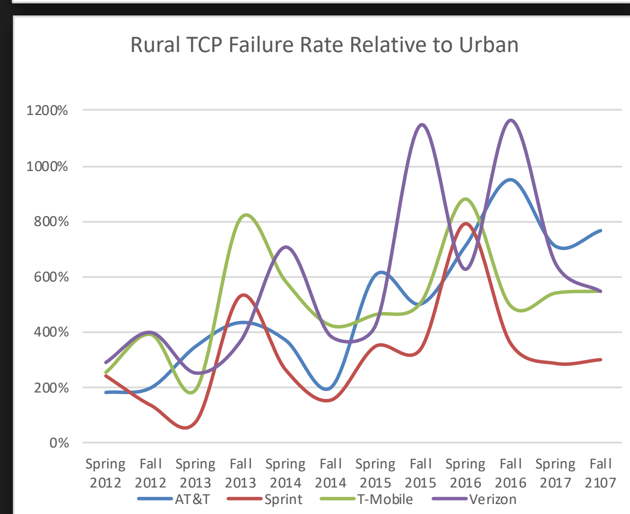


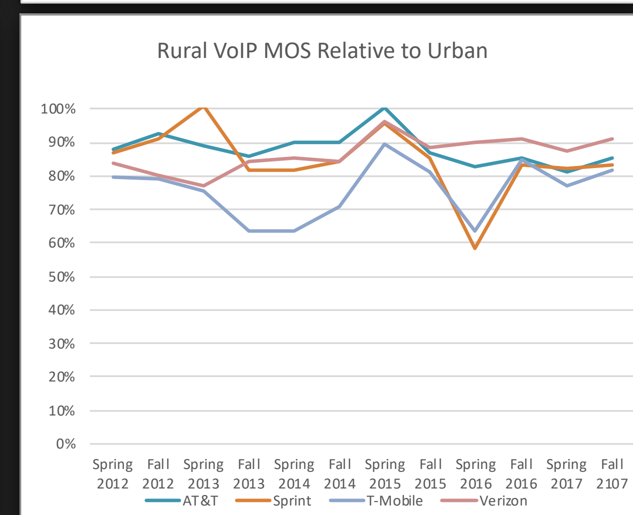


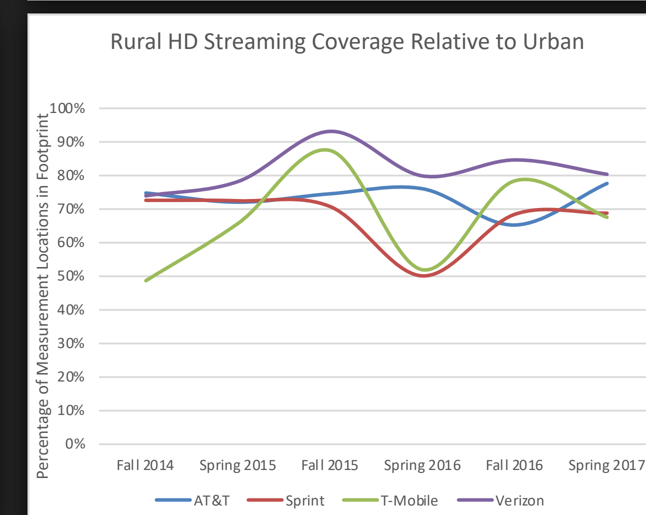


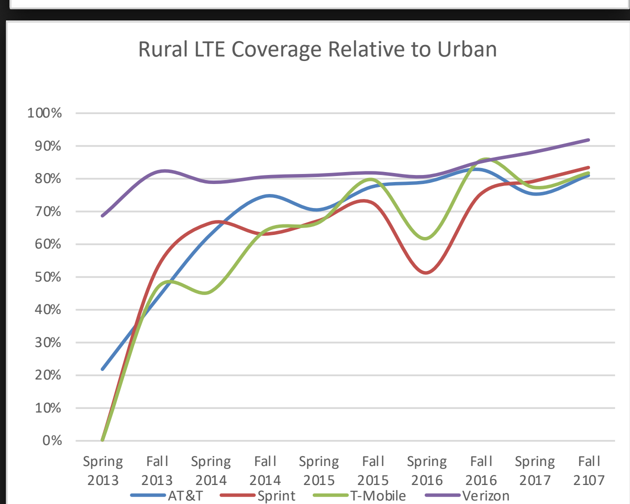


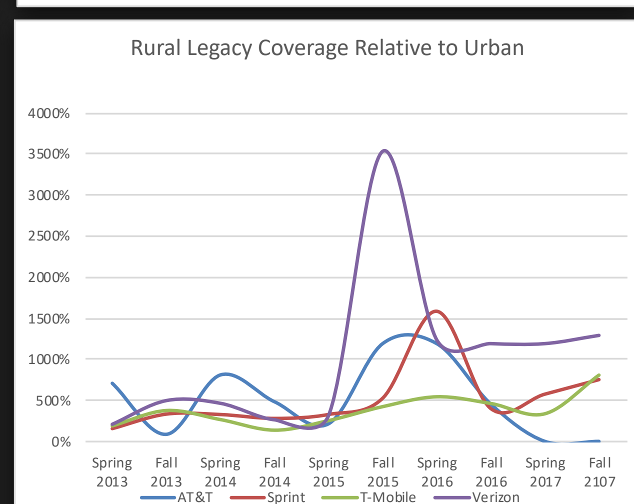


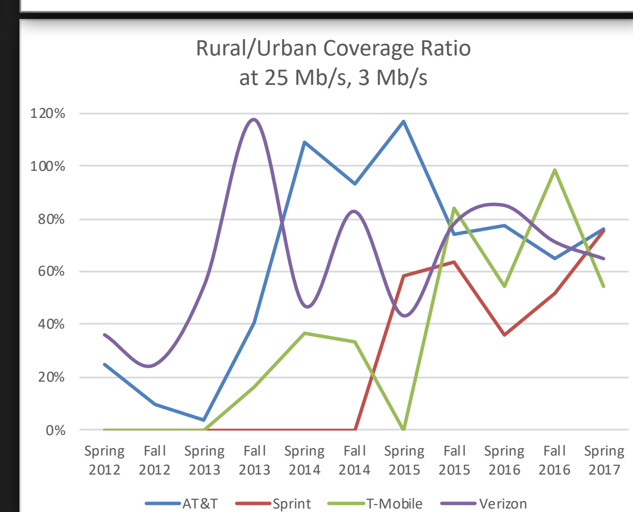




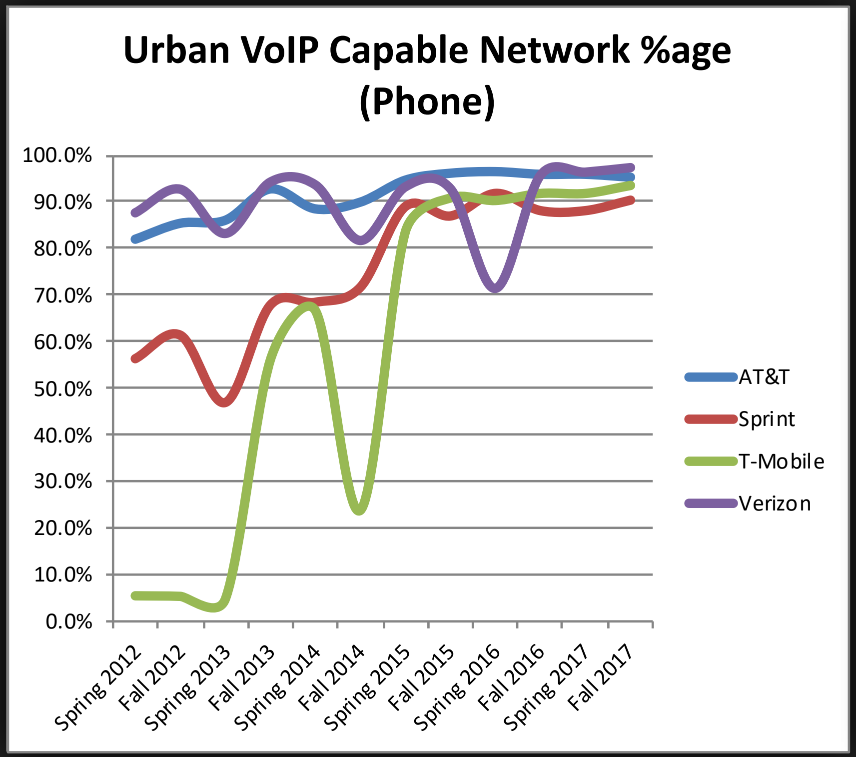


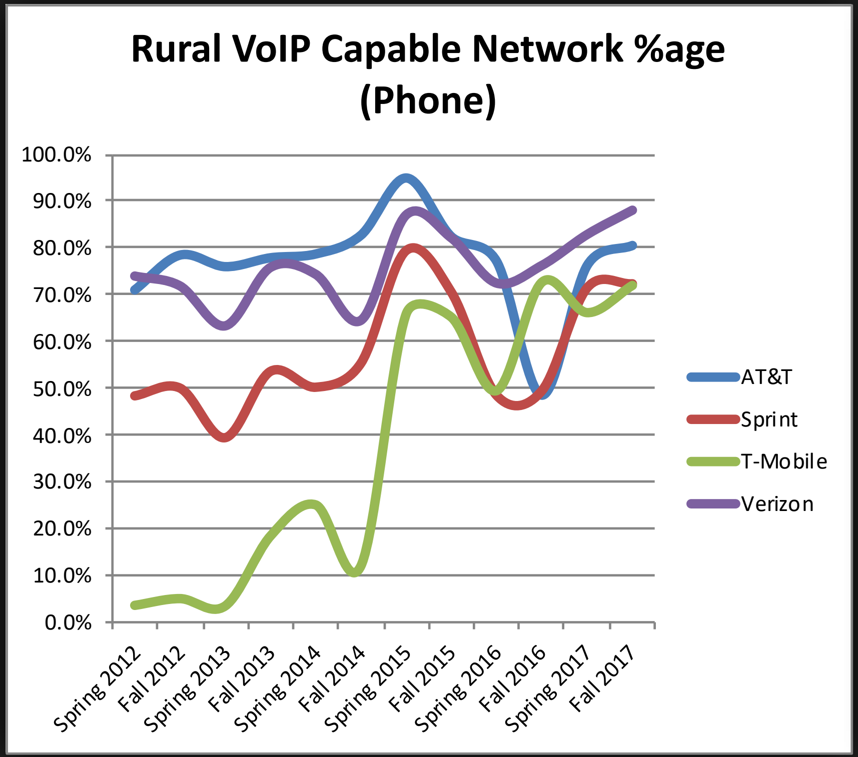


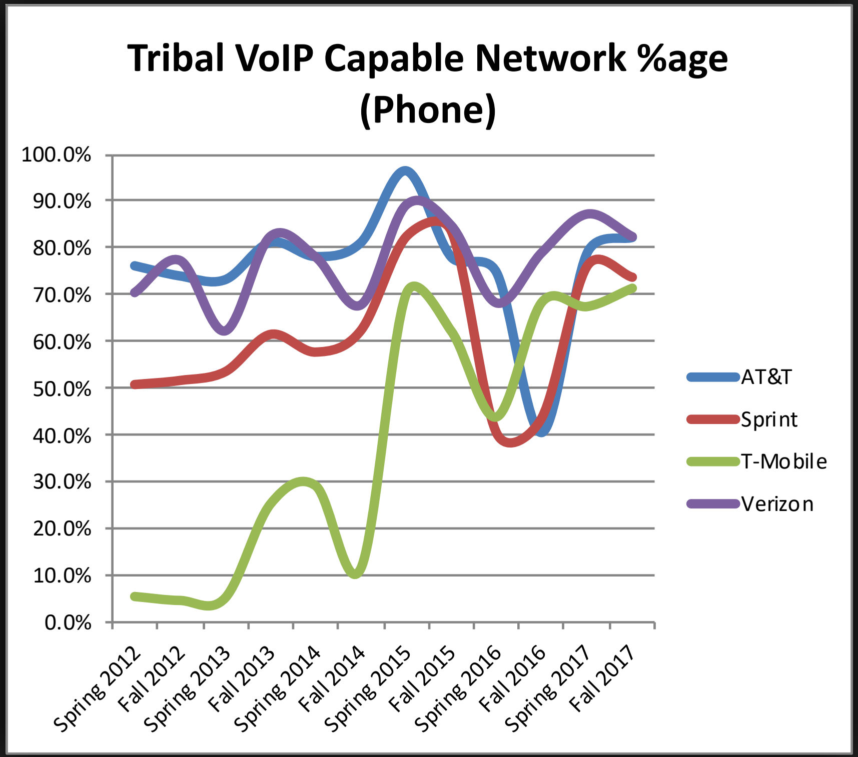




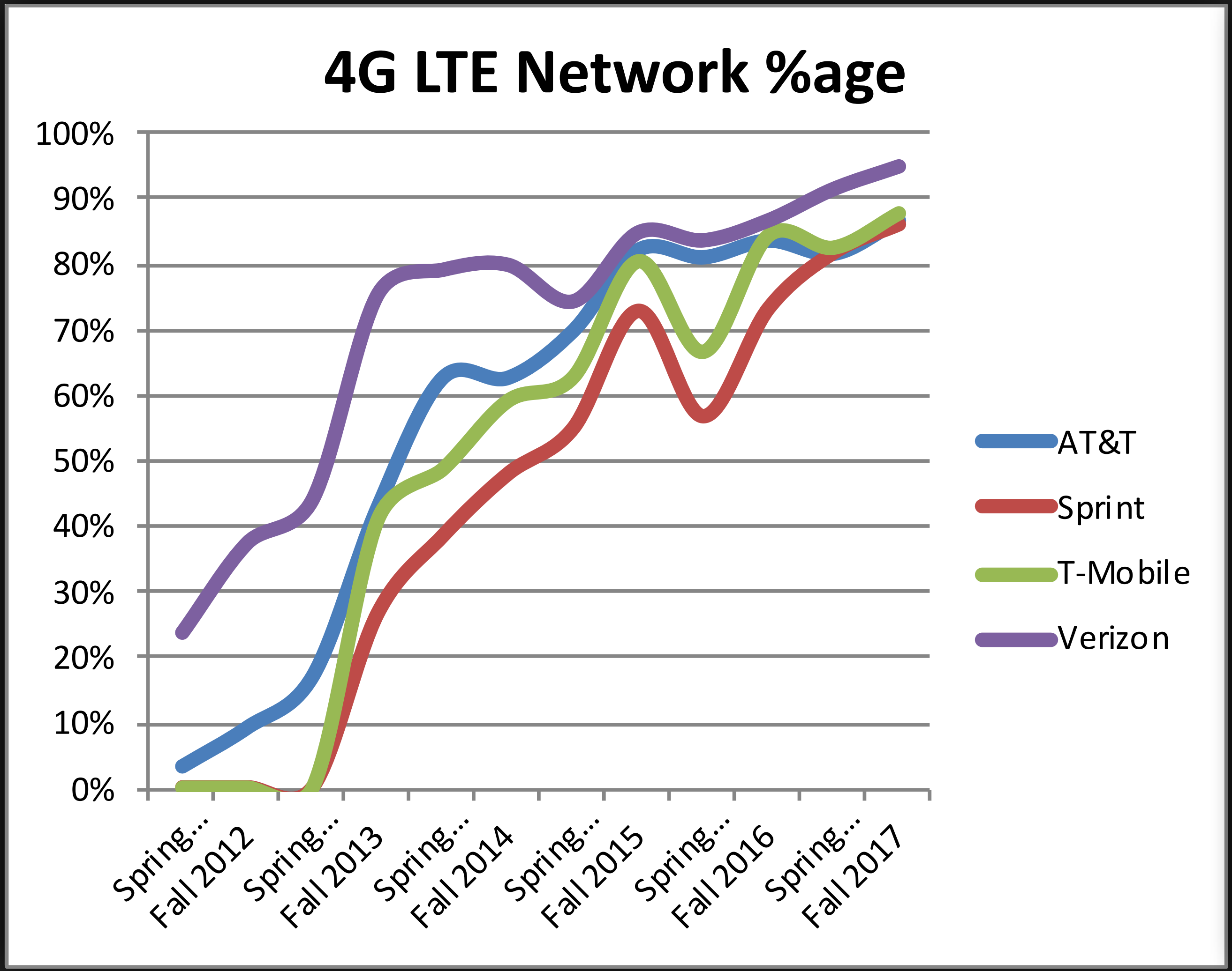
VOIP QUALITY BY DEMOGRAPHIC

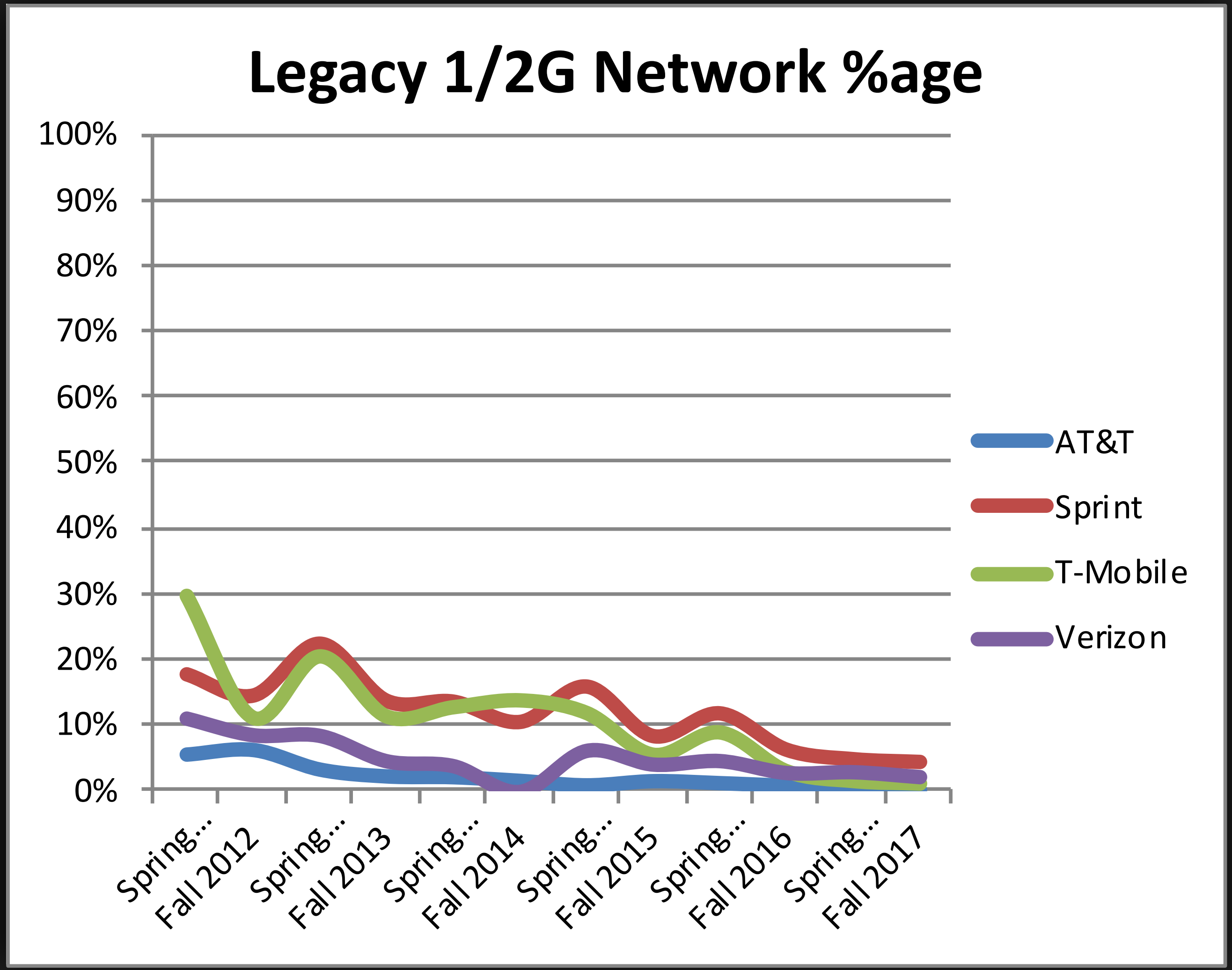




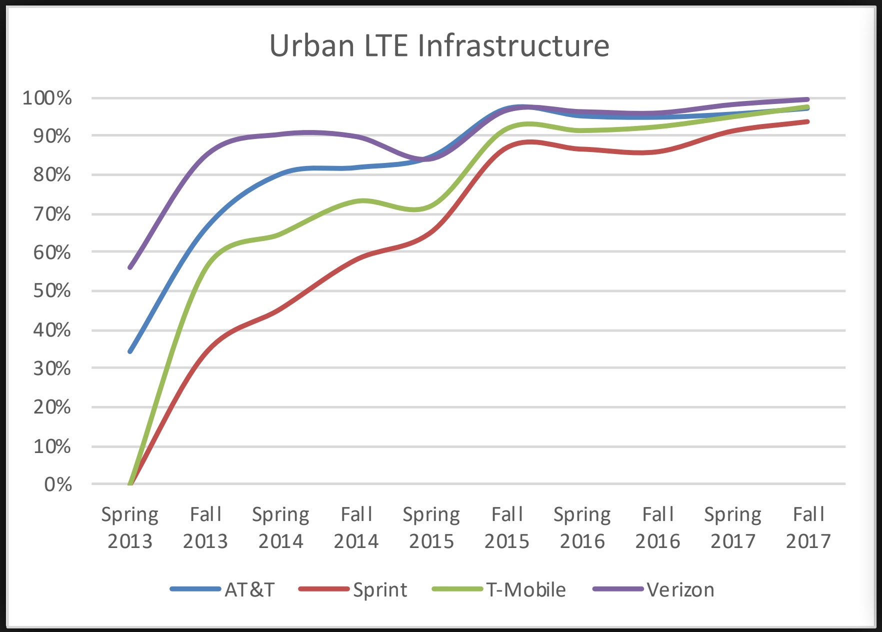


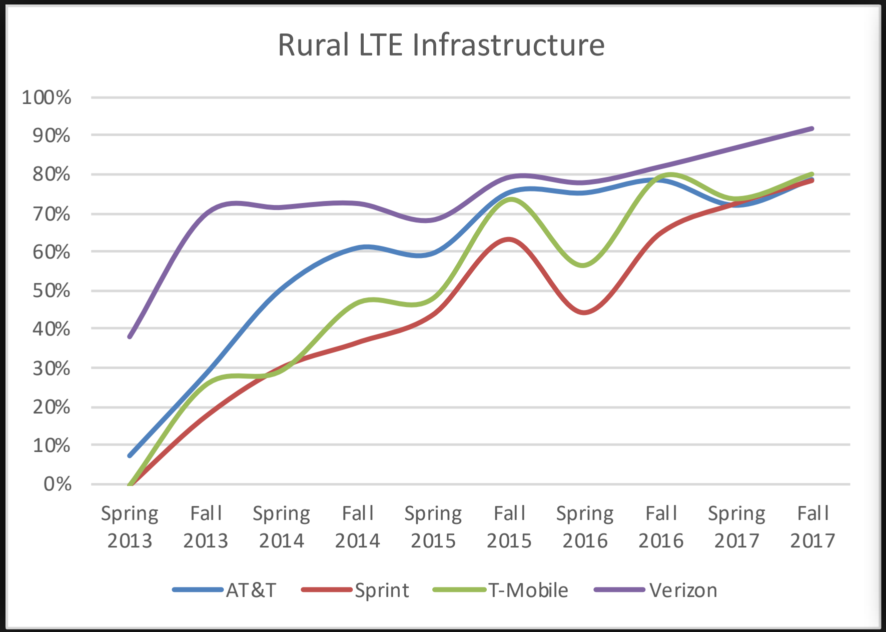
TECHNOLOGY FOR MORE PERFORMANCE

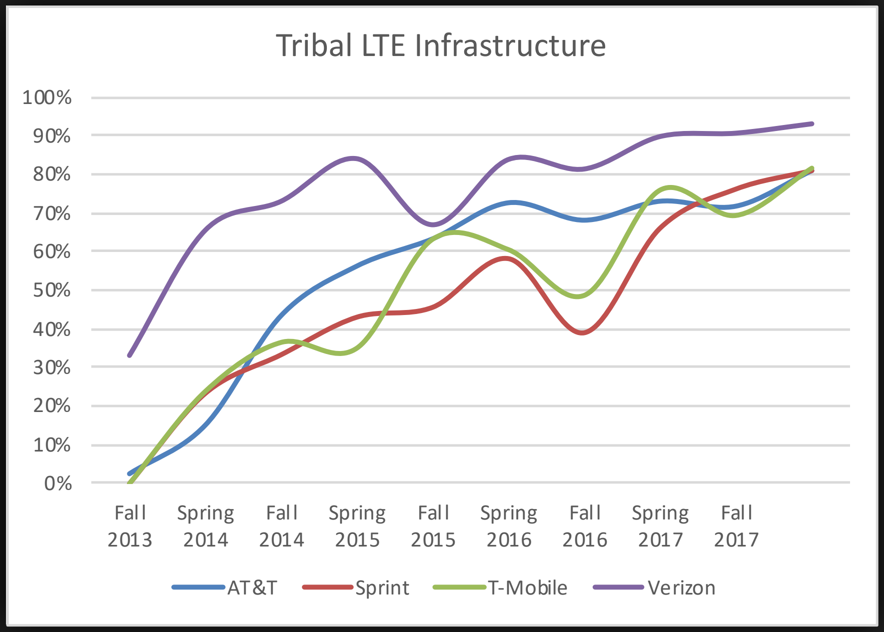


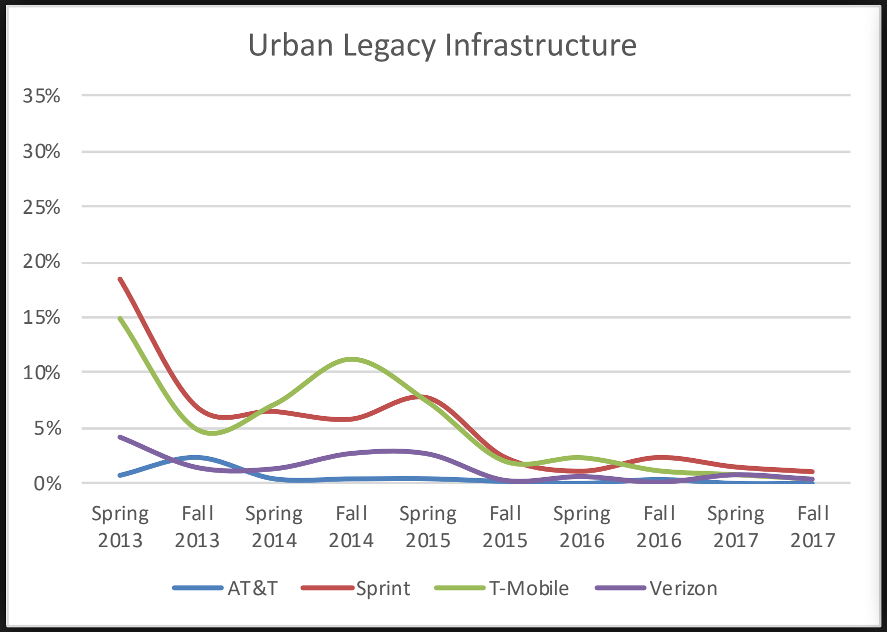


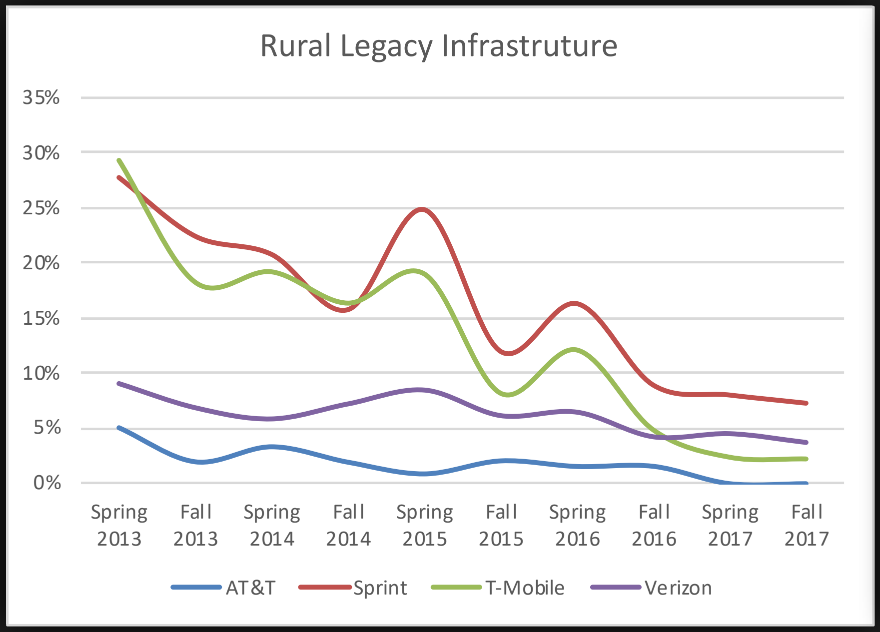
FOR SOME MORE THAN OTHERS

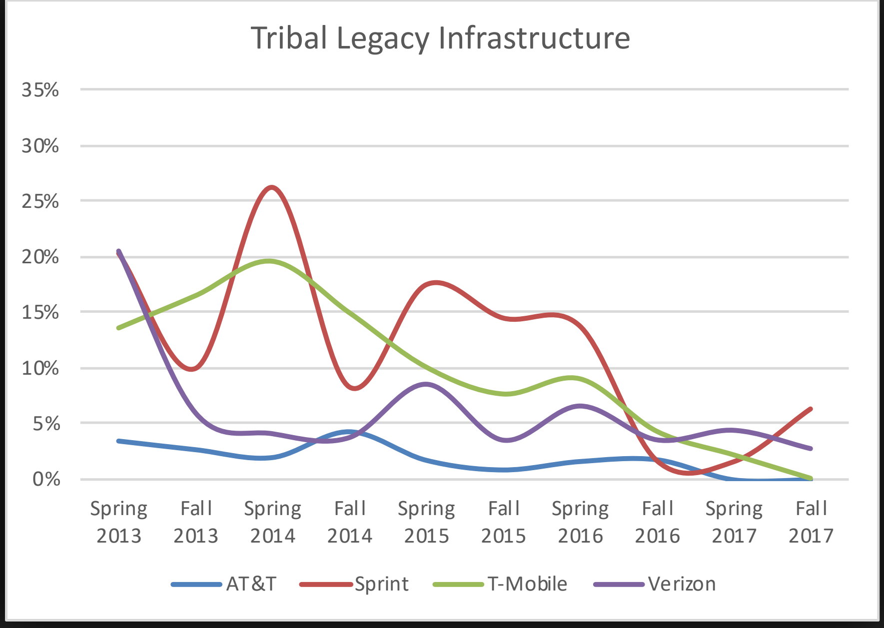






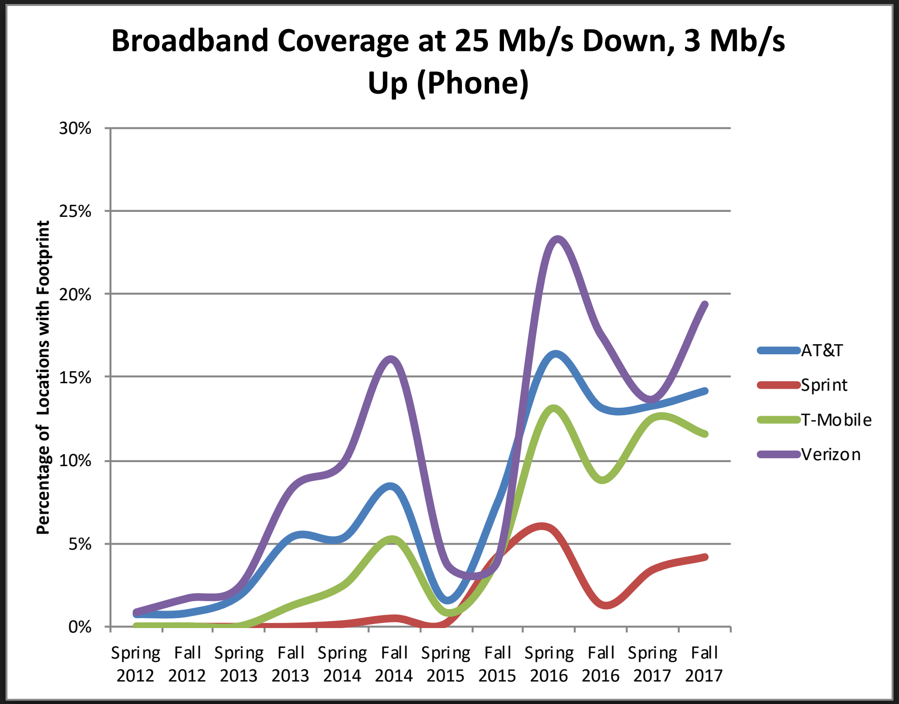


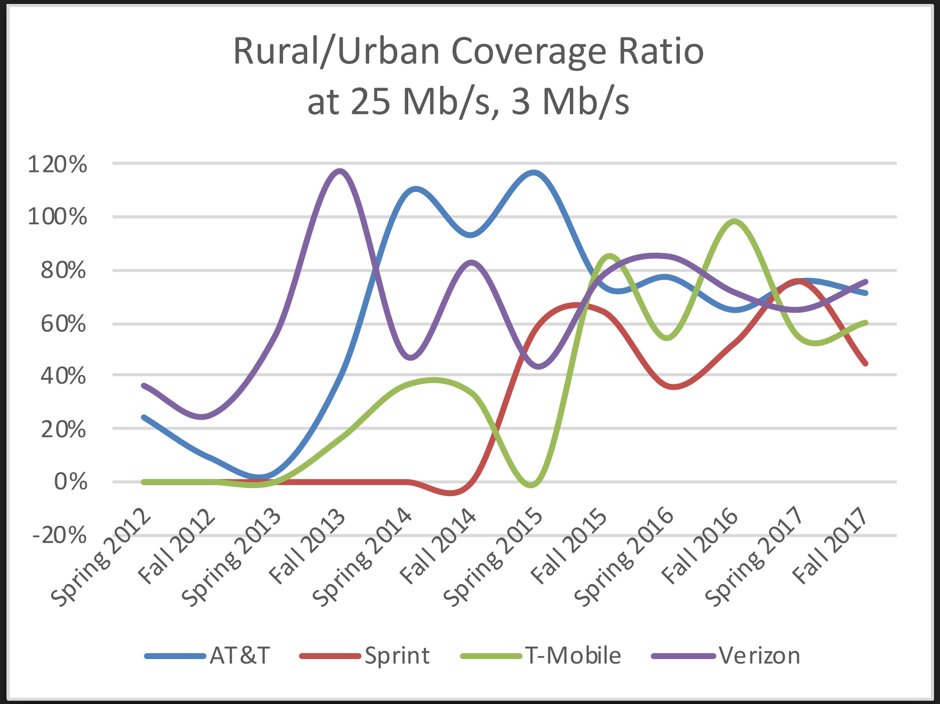


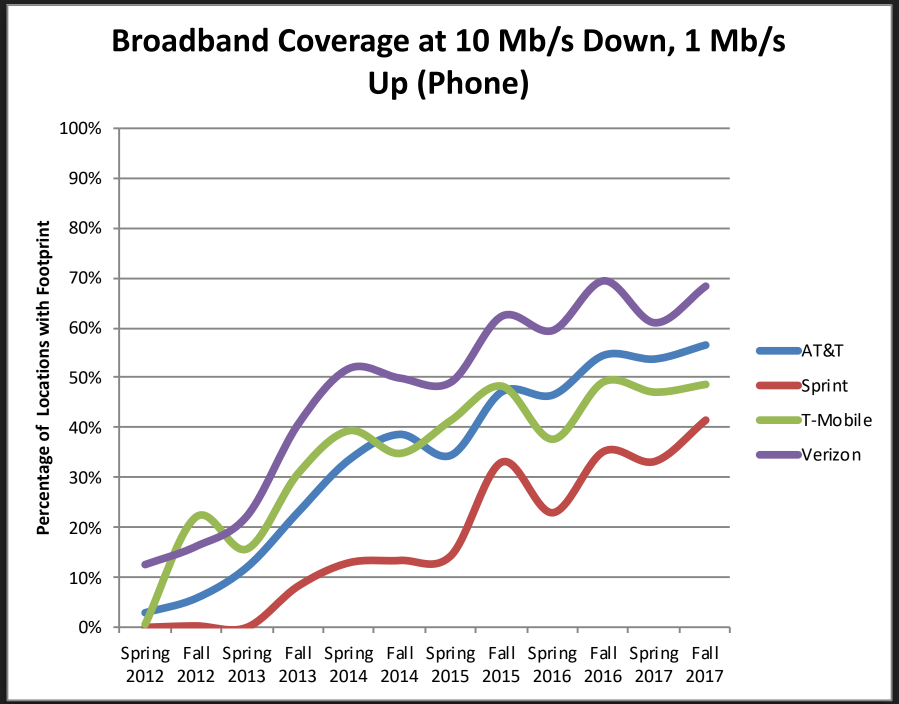


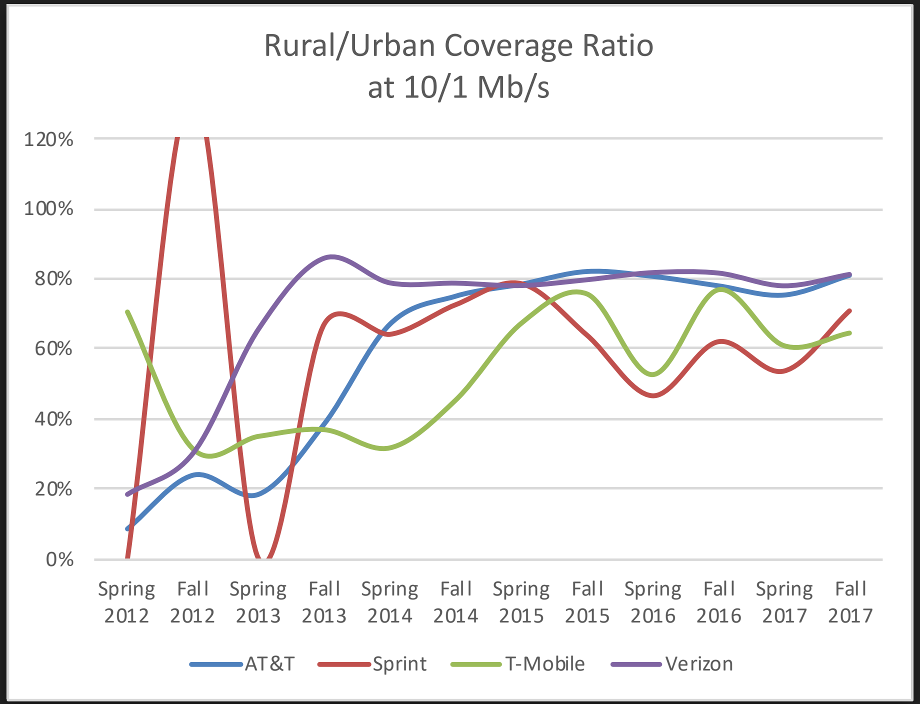
WHAT IS BROADBAND?

AND WHO GETS IT?





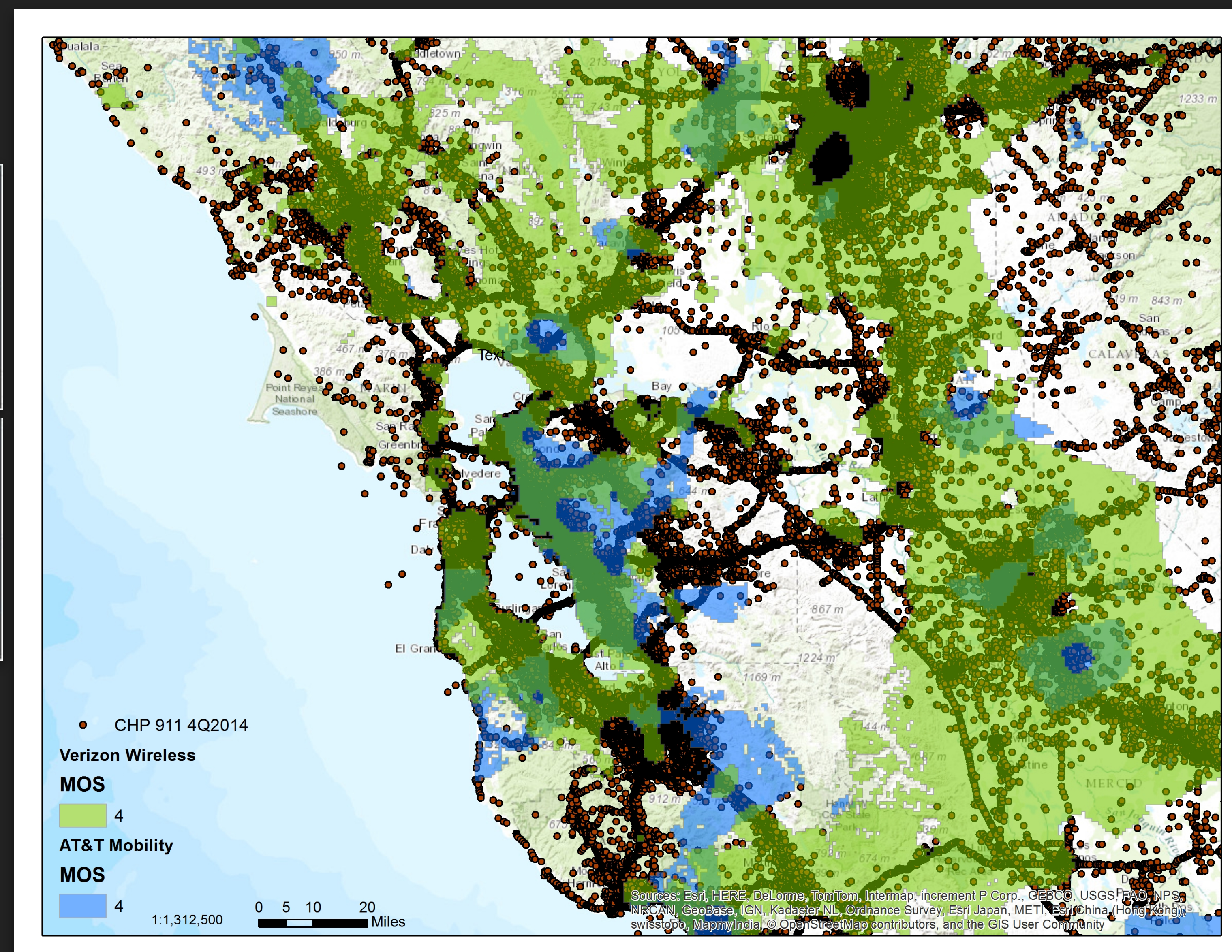




SF BAY 911 VS VOIP QUALITY (2014)

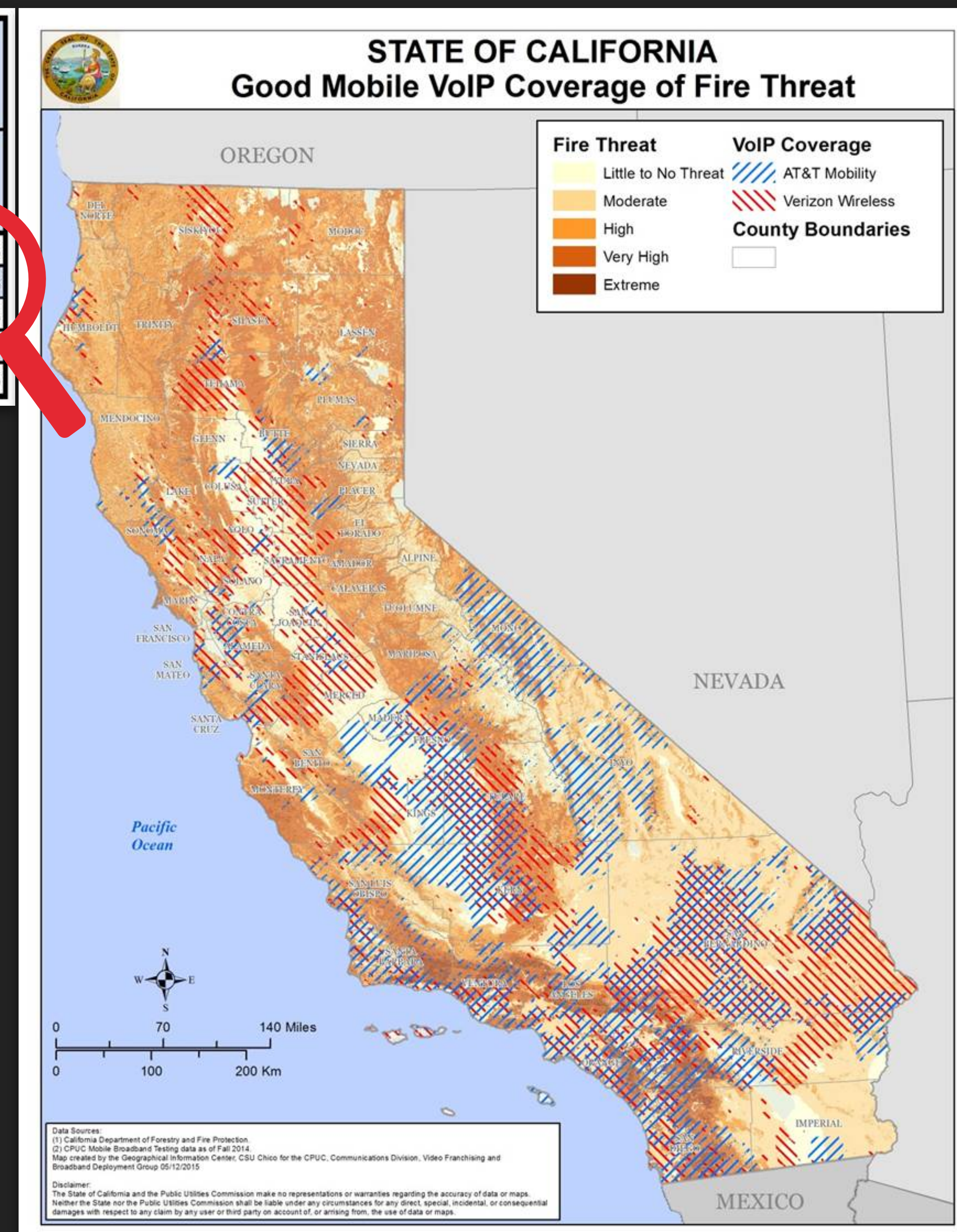
AT&T Mobility "Good" VoIP Coverage			
Number of Calls Without	Percent of Calls Without	Number of Calls With	Percent of Calls With
3,297,260	48.09%	3,559,394	51.91%

Verizon Wireless "Good" VoIP Coverage			
Number of Calls Without	Percent of Calls Without	Number of Calls With	Percent of Calls With
2,399,405	34.99%	4,457,249	65.01%

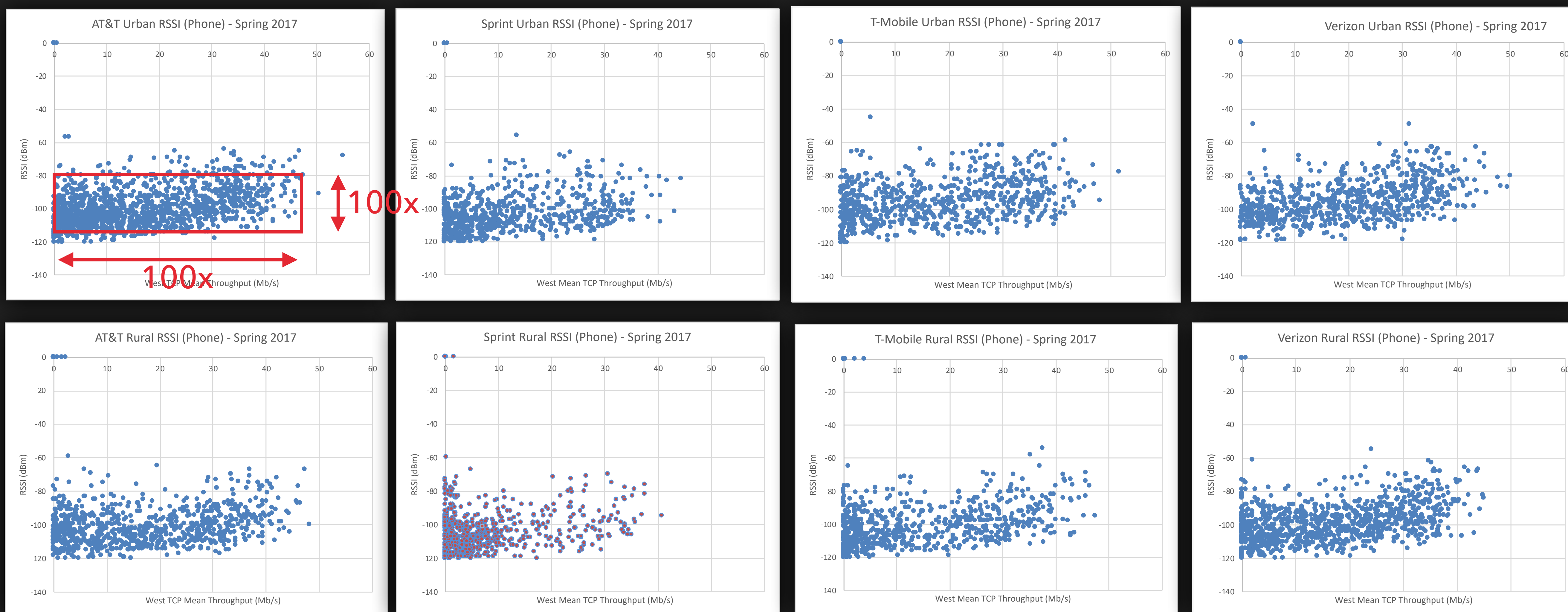


FIRE RISK VS VOIP QUALITY (2014)

FIRE THREAT		Verizon Wireless Good VoIP Coverage			AT&T Mobility Good VoIP Coverage		
Threat Rank	Total Area (Sq. Miles)	Area Without	Area With	Percent Area Without	Area Without	Area With	Percent Area Without
Extreme	3,059	2,351	709	77%	1,397	1,663	46%
Very High	40,090	33,242	6,848	83%	32,706	7,384	82%
High	33,313	27,763	5,549	83%	27,613	5,699	83%
Moderate	56,911	37,956	18,955	[illegible]	38,945	17,965	[illegible]
Little to No Threat	24,780	16,014	8,766	65%	16,491	8,289	67%



MYTHBUSTERS: BARS ≠ PERFORMANCE



- Its not the signal, its the noise
  - RSSI correlates ~0.2
  - SNR correlates ~0.6

GOING FORWARD

- Continue mobile assessment
  - Rural 5G???
  - Middle mile vs last mile
  - Carrier throttling
  - Smart agriculture
  - Quality
- Extend to residential wired Internet
  - Same tools, same analysis
  - $80 CalSPEED Measurement Engine: GigE+2x2 MIMO WiFi.ac
  - Deployment later 2018
- Add residential WiFi
  - Vast majority of user devices
- Conjecture: the great WiFi gap

MORE . . .

Questions	ken@novarum.com
California Interactive Broadband Map	www.broadbandmap.ca.gov
Code	gitHub.com/CalSPEED
Analysis	www.cpuc.ca.gov
Field Measurement Blog	calbroadbanddrivetest.blogspot.com
Crowd Sourcing Apps	App Store Play