BETTER SIGNAL,
BETTER SERVICE:
Single Frequency Networks

SMPTE/SBE NEXTGEN TV Summit

January 16, 2020

PMG

OSBORN ENGINEERING

NextGenTV™ SUMMIT

Produced by SMPTE and SBE with support from the NAB and ATSC

and the support of our host, WETA Television

WETA

JANUARY 16, 2020

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Greg Smalfelt Ch 16 Fairfax
Alex Snell BCI Digital
Peter Wharton Happy Robotz

WITHOUT THEIR VOLUNTEER EFFORTS THIS SUMMIT WOULD NOT BE POSSIBLE

Morning Program

8:00 AM - 9:00 AM	Registration and continental breakfast
8:55 AM - 9:00 AM	**Welcome from SMPTE, SBE and AES** Fred Willard, SBE Washington Kishore Persaud, SBE Baltimore
9:00 AM - 9:05 AM	**Introduction** Peter Wharton, SMPTE Membership VP Chris Lane, Chief Engineer, WETA
9:05 AM - 9:35 AM	**NextGen TV: Transforming the Consumer Experience** Lynn Claudy, SVP Technology, NAB and Chairman, ATSC Board of Directors Madeleine Noland, President, ATSC
9:35 AM - 10:00 AM	**Creating New Opportunities with NextGen TV** Joonyoung Park, VP and Fellow, DigiCAP
10:00 AM - 10:35 AM	**Improved Television Reception for Consumers** *Implementing NextGen TV Distribution Systems* John Lynch, ERI Jeff Andrew, Osborn Engineering
10:35 AM - 11:15 AM	**Benefits of a Converged Broadcast and IP Platform** Lynn Claudy, SVP Technology, NAB and Chairman, ATSC Board of Directors **Content Reception Enhancements** Richard Lhermitte, VP Solutions and Market Dev, ENENSYS TeamCast
11:15 AM - 11:30 AM	Morning Break
11:30 AM - 11:50 AM	**Consumer Applications for Combined 5G & NextGen TV Networks** Josh Arensberg, M&E Business Development, Verizon Media
11:50 AM - 12:15 PM	**Case Study: Hybrid Services at "Chicago 3.0"** Jean Macher, Harmonic
12:15 PM - 01:20 PM	Buffet Lunch

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Afternoon Program

01:25 PM - 01:45 PM	**Protecting the NextGen TV Consumer** *Advanced EAS and AWARN Capabilities* John McCoskey, SpectraRep
01:45 PM - 02:15 PM	**Monetizing the NextGen TV Consumer** *Addressable Advertising and Analytics* Rick Ducey & Mark Fratrik, BIA
02:20 PM - 03:20 PM	**Personalizing the Consumer Experience** *Interactive and Personalized Features* Mark Corl, Triveni Digital Greg Jarvis, Fincons So Vang, NAB Pete Van Peenan, Pearl TV
03:25 PM - 03:40 PM	Afternoon Break
03:40 PM - 04:10 PM	**The Consumer Out-of-Home Experience** *Mobile & Automotive Applications and FeMBMS (5G Broadcast)* Thomas Janner, Product Management & R&D Director, Rhode & Schwarz
4:10 PM - 4:35 PM	**The ATSC 3.0 Roadmap** Lynn Claudy, SVP Technology, NAB and Chairman, ATSC Board of Directors Madeleine Noland, President, ATSC
4:35 PM - 5:00 PM	**The Consumer Technology Roadmap** Brian Markwalter, SVP Research and Standards The Consumer Technology Association
5:00 PM - 6:00 PM	**Station Group and Industry Deployment Plans** *Advanced Capability Implementation Strategies* Skip Pizzi, VP Technology Education & Outreach, NAB (Moderator) Michael Bouchard, VP Technology Strategy, ONE Media / Sinclair Stacey Decker, CTO, Public Media Group Sasha Javid, COO, The Spectrum Co
6:00 PM - 8:00 PM	**Cocktail Reception** Busboys and Poets 4251 S. Campbell Ave.,Shirlington *Heavy Hors d'oeuvres and open bar*

Improving Reception using NextGen TV

- A Single Frequency Network (SFN) will Improve Reception for Consumers:
  - A cellular approach to infrastructure
  - Keep the bit rate up for mobile, portable, and building penetration
- Layered Division Multiplexing: more data capacity in the same 6Mhz
- Need to transition a market to ATSC 3.0 with SFNs in mind

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Why SFNs?

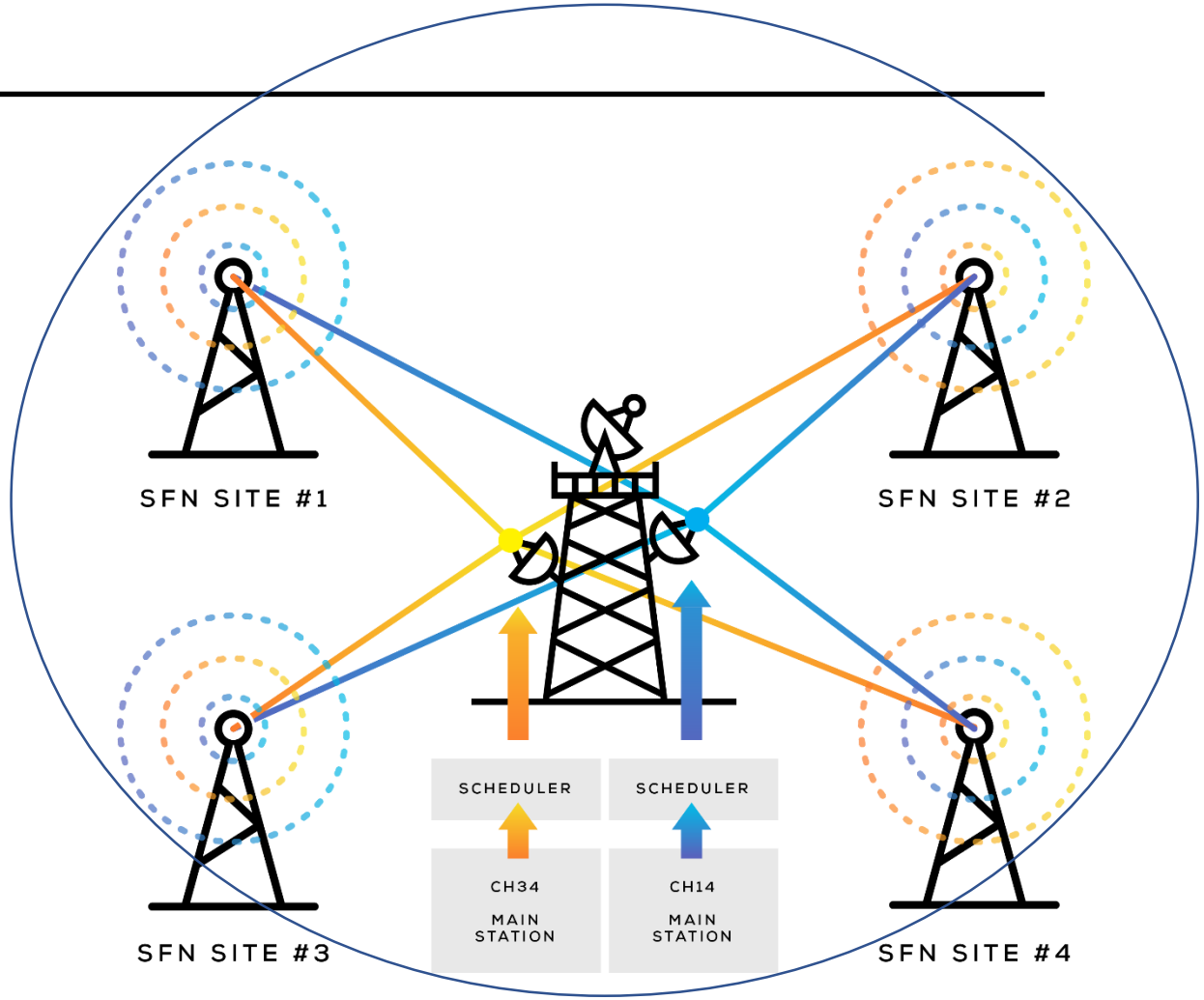
What is an SFN? A broadcast network where several transmitters simultaneously send the same signal over the same frequency channel.

Why are they important? An SFN fills in gaps and improves reception, including to mobile devices, which enables broadcasters to provide more comprehensive services to the community and generate greater revenues.

Deliver Better ATSC 3.0 Service with Shared Infrastructure

SFNs should be **co-located** and utilize shared infrastructure (sites, towers, antennas, etc.) for operational efficiency.

Shared infrastructure delivers economies of scale, reducing costs and improving service.



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Goals for SFNs

- Improve over the air coverage area for TV sets, hand-held, and mobile devices
- Provide consistent City Grade signal across the coverage area
- Improve OTA service significantly
- Provide a data conduit for new revenue opportunities

SFN Design Criteria

- Generate received levels in the 75 to 80 dBu range for UHF stations
- 25 MB bit rate minimum total data rate in Core layer
- 19.2 dB C/N base case for this study
- Validate with other use cases based on client input
- Pick guard interval based on available transmitter spacing
- Use existing towers, if possible, for faster implementation

San Francisco SFN Modelling

- Engineering Studies performed using Progira Software

- Modelled channels:
- 36 KICU
- 28 KCBW
- 7 KRON

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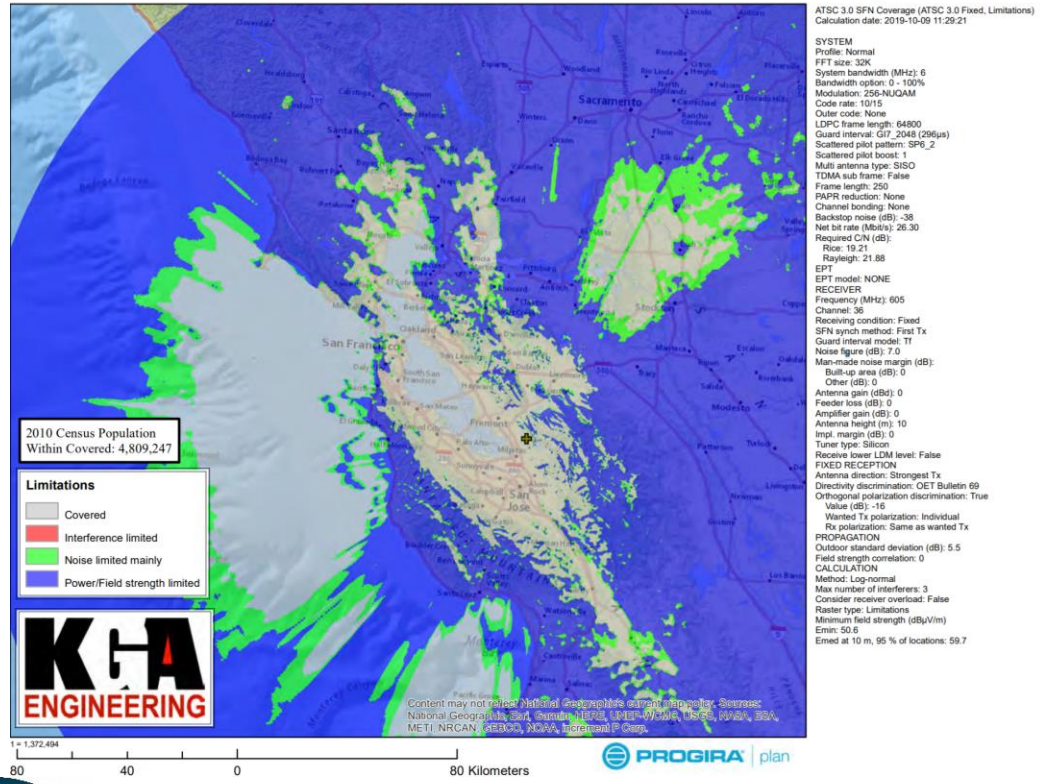
Preliminary SFN Design – 10 Meters

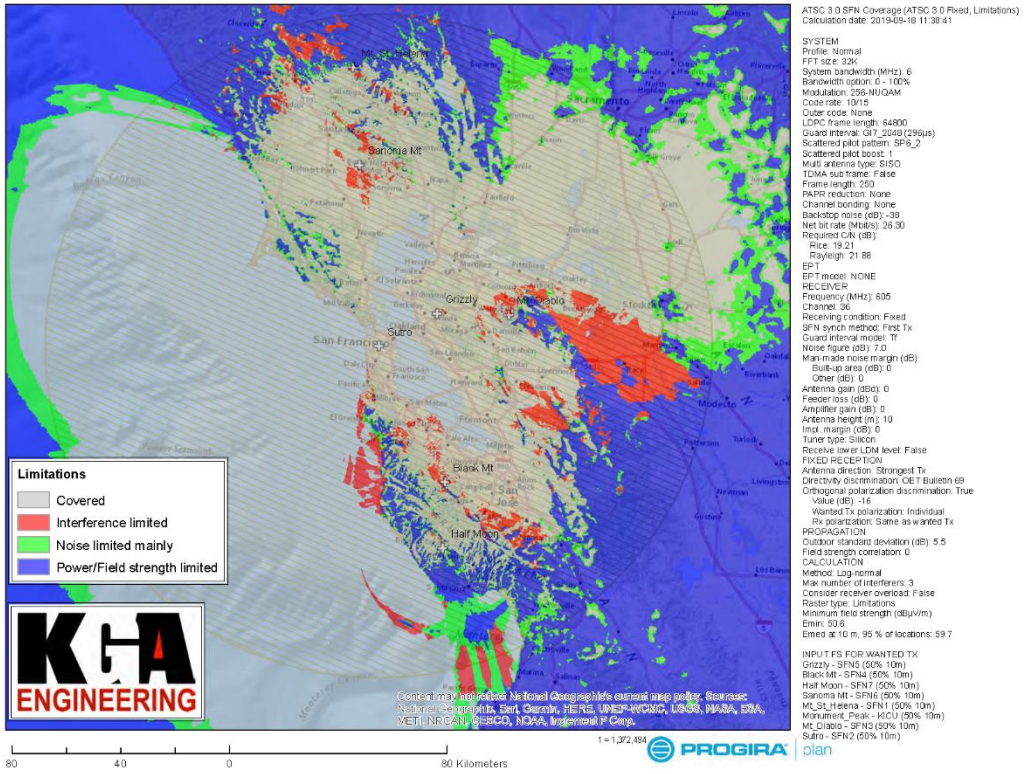
One Site

San Francisco ATSC 3.0 KICU License Channel 36 - 10m Fixed Reception



Seven-Site SFN

San Francisco ATSC 3.0 SFN Channel 36 - 10m Fixed Reception - IX Compliant



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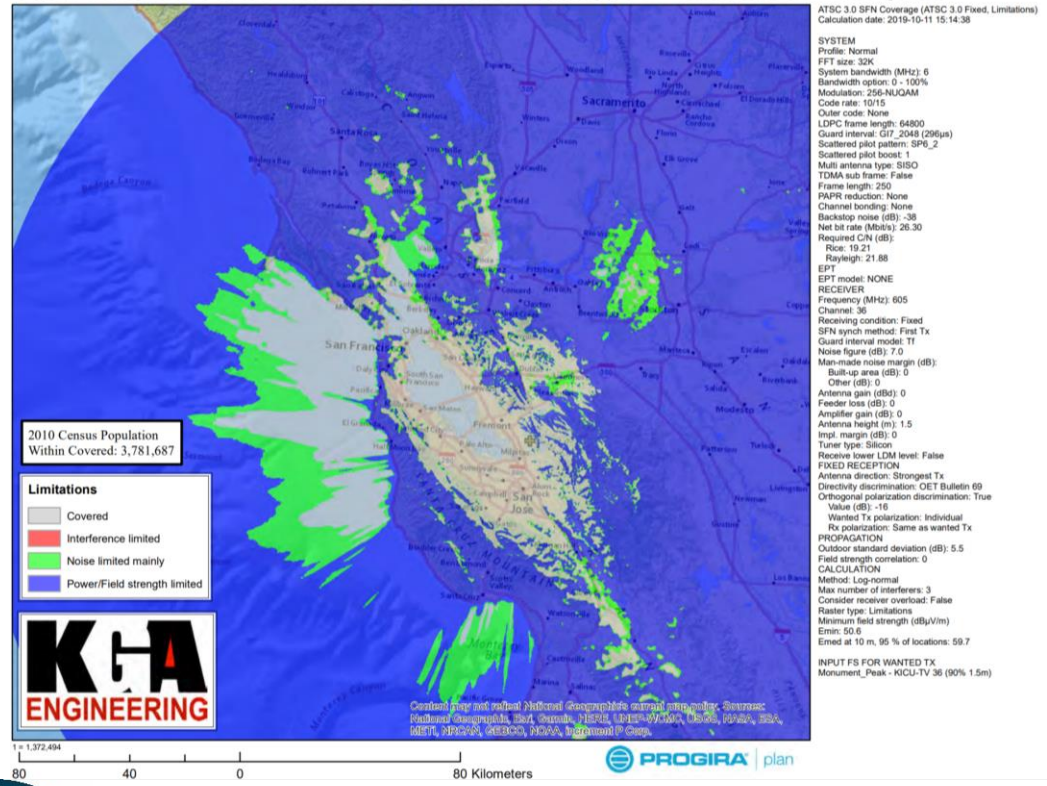
Preliminary SFN Design – 1.5 Meters

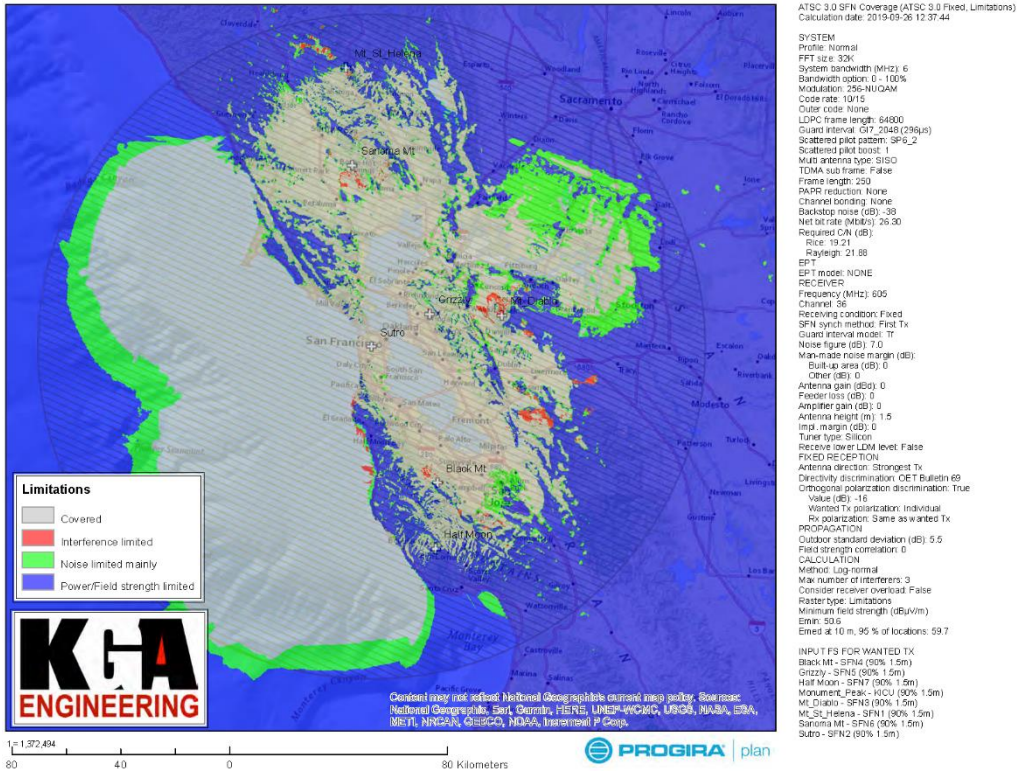
One Site

San Francisco ATSC 3.0 KICU License Channel 36 - 1.5m Fixed Reception



Seven-Site SFN

San Francisco ATSC 3.0 SFN Channel 36 - 1.5m Fixed Reception - IX Compliant



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Pop Gains

Station	10 M Pop	1.5 M Pop
KRON 7	4,854,209	3,391,510
KRON 7 w/SFN	6,934,042	5,715,114
Pop Gain	**2,079,833**	**2,323,604**
KBCW 28	5,382,824	3,722,186
KBCW 28 w/SFN	6,404,428	4,240,821
Pop Gain	**1,021,604**	**518,635**
KICU 36	4,809,247	3,781,687
KICU 36 w/SFN	6,832,201	5,211,788
Pop Gain	**2,022,954**	**1,430,101**

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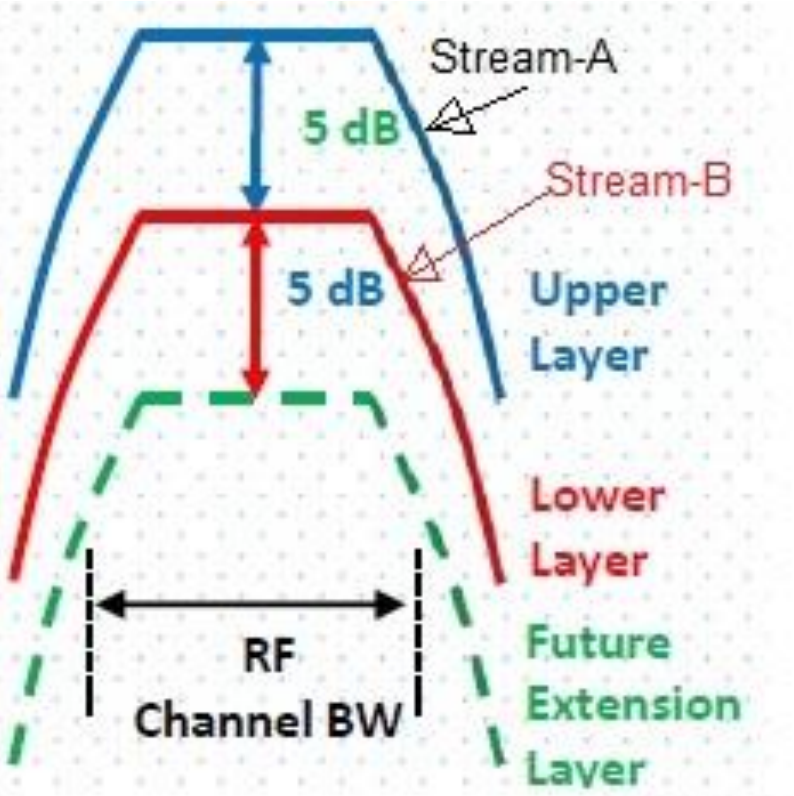
Layered Division Multiplexing (LDM)

- Part of the ATSC-3.0 (A-327) standard
- Allows for an additional modulated carrier with a power level lower than the main layer to enable additional data capacity – ATSC refers to these layers as the **“core” and “enhancement” layers**
- Can be used in single transmitter or multi (SFN) implementations

Layered Division Multiplexing (LDM)

- Turning on the enhancement layer at recommended levels does not have any material impact on the core layer reception
- The enhancement layer can use different mod-cods depending on the use case



LDM Overlay Spectrum

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LDM Potential Use Cases

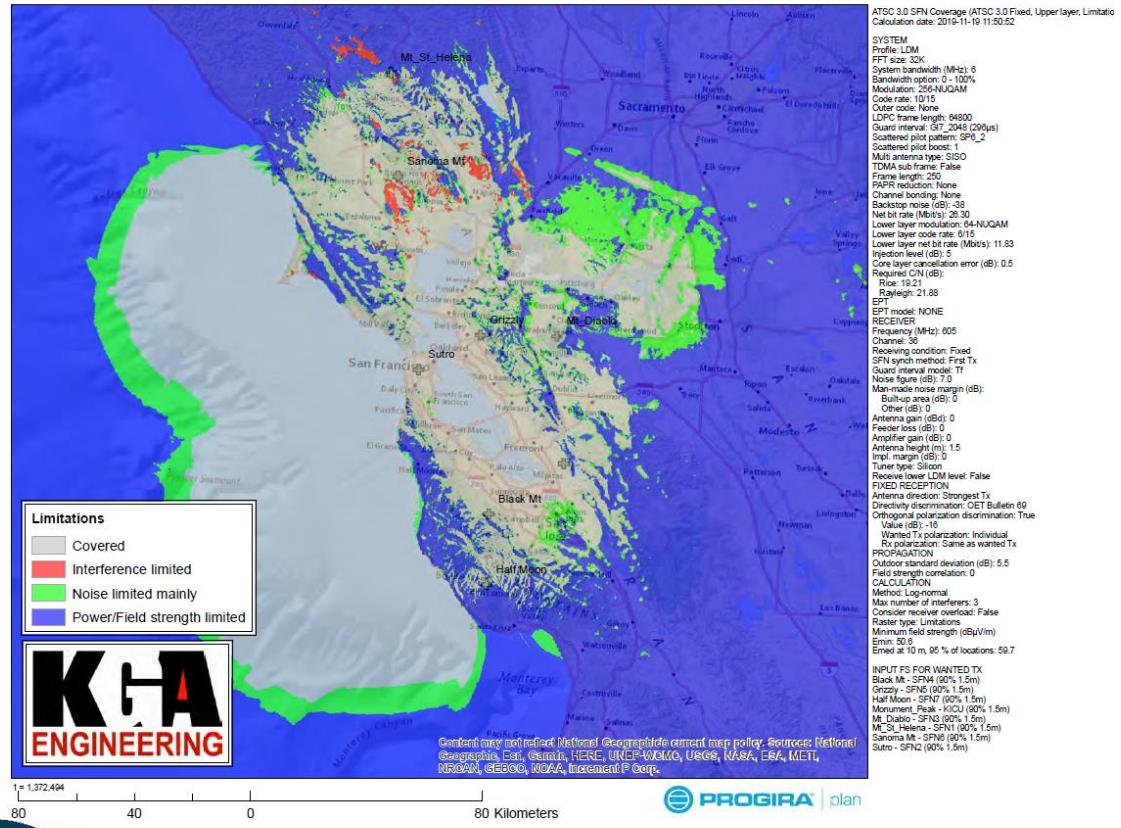
- Broadband data across the DMA via a multi-transmitter SFN design for data streaming
- Additional program streams
- Program enhancement layers to add 4K or HDR
- Emergency messaging/warnings
- Typical Enhanced layer capability will match core layer coverage at around 10 Mb
- Use cases will define the Mod Cod

Mod-cod Selection Controls the Use Case

- Similar to the Core layer, the mod-con selection will vary with the application
- Select a highly robust mod-cod when the bits need to go everywhere reliably to low signal areas
- Select a less robust mod-cod when the bits are not as critical in low signal applications

LDM

San Francisco - Ch 36 - IX Compliant - 1.5m - Core Layer - Covered

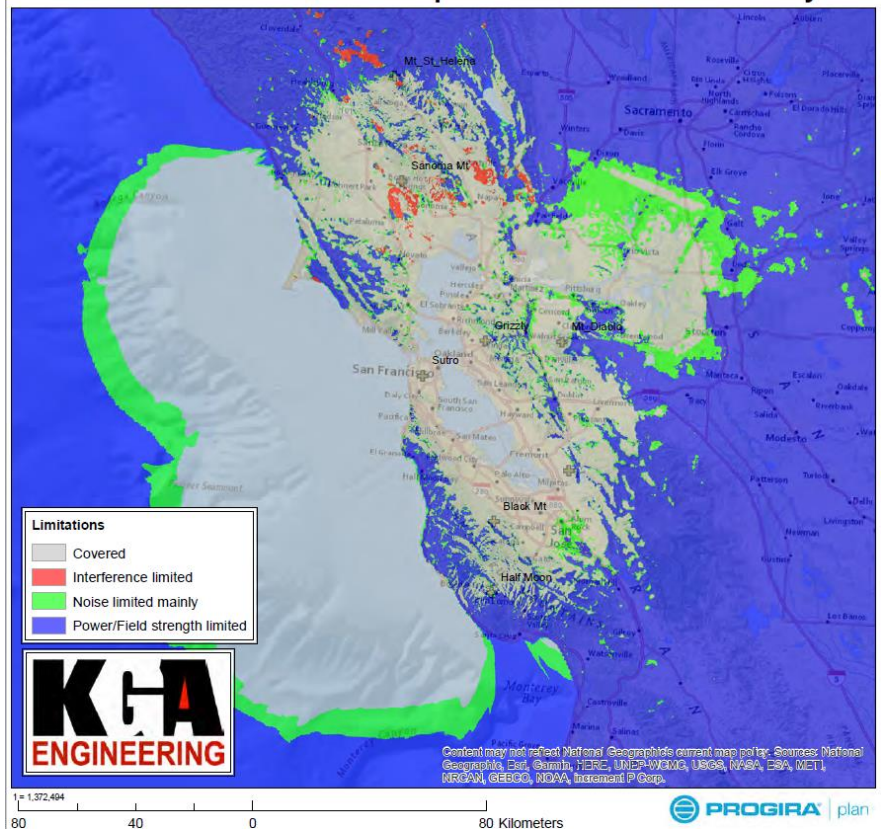


ATSC 3.0 SFN Coverage (ATSC 3.0 Fixed, Upper layer, Limitatio
Calculation date: 2019-11-19 11:50:52

SYSTEM
Profile: LDM
FFT size: 32K
System bandwidth (MHz): 6
Bandwidth option: 0 - 100%
Modulation: 256-NUQAM
Code rate: 10/15
Outer code: None
LDPC frame length: 64800
Guard interval: GI7_2048 (296µs)
Scattered pilot pattern: SP6_2
Scattered pilot boost: 1
Multi antenna type: SISO
TDMA sub frame: False
Frame length: 250
PAPR reduction: None
Channel bonding: None
Backstop noise (dB): -38
Net bit rate (Mbit/s): 26.30
Lower layer modulation: 64-NUQAM
Lower layer code rate: 6/15
Lower layer net bit rate (Mbit/s): 11.83
Injection level (dB): 5
Core layer cancellation error (dB): 0.5
Required C/N (dB):
Rice: 19.21
Rayleigh: 21.88
EPT
EPT model: NONE
RECEIVER
Frequency (MHz): 605
Channel: 36
Receiving condition: Fixed
SFN synch method: First Tx
Guard interval model: TF
Noise figure (dB): 7.0
Man-made noise margin (dB):
Built-up area (dB): 0
Other (dB): 0
Antenna gain (dBd): 0
Feeder loss (dB): 0
Amplifier gain (dB): 0
Antenna height (m): 1.5
Impl. margin (dB): 0
Tuner type: Silicon
Receive lower LDM level: False
FIXED RECEPTION
Antenna direction: Strongest Tx
Directivity discrimination: OET Bulletin 69
Orthogonal polarization discrimination: True
Value (dB): -16
Wanted Tx polarization: Individual
Rx polarization: Same as wanted Tx
PROPAGATION
Outdoor standard deviation (dB): 5.5
Field strength correlation: 0
CALCULATION
Method: Log-normal
Max number of interferers: 3
Consider receiver overload: False
Raster type: Limitations
Minimum field strength (dBµV/m)
Emin: 50.6
Emed at 10 m, 95 % of locations: 59.7

INPUT FS FOR WANTED TX
Black Mt - SFN4 (90% 1.5m)
Grizzly - SFN5 (90% 1.5m)
Half Moon - SFN7 (90% 1.5m)
Monument_Peak - KICU (90% 1.5m)
Mt_Diablo - SFN3 (90% 1.5m)
Mt_St_Helena - SFN1 (90% 1.5m)
Sanoma Mt - SFN6 (90% 1.5m)
Sutro - SFN2 (90% 1.5m)

San Francisco - Ch 36 - IX Compliant - 1.5m - Enhanced Layer - Covered



ATSC 3.0 SFN Coverage (ATSC 3.0 Fixed, Lower layer, Limitati
Calculation date: 2019-11-11 15:49:03

SYSTEM
Profile: LDM
FFT size: 32K
System bandwidth (MHz): 6
Bandwidth option: 0 - 100%
Modulation: 256-NUQAM
Code rate: 10/15
Outer code: None
LDPC frame length: 64800
Guard interval: GI7_2048 (296µs)
Scattered pilot pattern: SP6_2
Scattered pilot boost: 1
Multi antenna type: SISO
TDMA sub frame: False
Frame length: 250
PAPR reduction: None
Channel bonding: None
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Lower layer modulation: 64-NUQAM
Lower layer code rate: 6/15
Lower layer net bit rate (Mbit/s): 11.83
Injection level (dB): 5
Core layer cancellation error (dB): 0.5
Required C/N (dB):
Rice: 16.39
Rayleigh: 18.14
EPT
EPT model: NONE
RECEIVER
Frequency (MHz): 605
Channel: 36
Receiving condition: Fixed
SFN synch method: First Tx
Guard interval model: TF
Noise figure (dB): 7.0
Man-made noise margin (dB):
Built-up area (dB): 0
Other (dB): 0
Antenna gain (dBd): 0
Feeder loss (dB): 0
Amplifier gain (dB): 0
Antenna height (m): 1.5
Impl. margin (dB): 0
Tuner type: Silicon
Receive lower LDM level: True
FIXED RECEPTION
Antenna direction: Strongest Tx
Directivity discrimination: OET Bulletin 69
Orthogonal polarization discrimination: True
Value (dB): -16
Wanted Tx polarization: Individual
Rx polarization: Same as wanted Tx
PROPAGATION
Outdoor standard deviation (dB): 5.5
Field strength correlation: 0
CALCULATION
Method: Log-normal
Max number of interferers: 3
Consider receiver overload: False
Raster type: Limitations
Minimum field strength (dBµV/m)
Emin: 47.8
Emed at 10 m, 95 % of locations: 56.9

INPUT FS FOR WANTED TX
Black Mt - SFN4 (90% 1.5m)
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Half Moon - SFN7 (90% 1.5m)
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Mt_Diablo - SFN3 (90% 1.5m)
Mt_St_Helena - SFN1 (90% 1.5m)
Sanoma Mt - SFN6 (90% 1.5m)
Sutro - SFN2 (90% 1.5m)

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Planning for SFN with the Market Transition

- Initial Planning of ATSC 3.0 Host stations

  - Channel assignments that support SFN deployment
  - Interference criteria for legacy ATSC 1.0 Stations
  - Planning for High V and UHF Stations.

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In Summary

Single Frequency Networks:

- Create a **uniform maximum receivable signal level** for all stations throughout the DMA;
- Allow for the **highest possible data rates** for mobile and portable reception;
- Can be used to replace some translators and save valuable spectrum; and
- Can be added at various locations and power levels to fill in marginal reception areas like highways for mobile applications.
- LDM can add additional multi-use data

SFNs will work best when planned for in the market transition to ATSC 3.0.

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Our Team

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Thank You.


FROM THE SMPTE WASHINGTON DC SECTION
THANK YOU