# Minnesota Public Safety Wireless Broadband Data Network Requirements Project

March 29, 2012

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# Agenda

1. Project Purpose
2. Project Methodology
3. Study Findings
   - Section 1: User Needs Assessment
   - Section 2: Network Requirements Statement
   - Section 3: Carrier Assessment
   - Section 4: Implementation Model
   - Section 5: Financial Models
4. FirstNet and a New National Model
5. Next Steps

# Project Purpose

# Project Purpose

## Goal:

*To provide Minnesota public safety officials with the essential information required for local, regional and national participation in the wireless public safety broadband process.*

# Project Purpose

## History

- 2008: Wireless Data Feasibility Study; recommendation make to explore partnerships
- 2008-2009: RFI seeking information on partnerships and public safety broadband
- Dec. 2010: Public safety wireless broadband study kicks off

# Project Purpose

## History

*Project starts in late December 2010. At that time:*

- No D Block certainty (was scheduled for auction)
- No Federal funding
- No national framework
- WiMAX still a viable option for public safety
- Users of spectrum limited to "sole or primary purpose of which is to protect life and safety"
- Uncertain legal basis for public/private partnerships
- No commercial 4G service (Verizon deployment starting)

# Project Purpose

## History

*Study concludes Spring 2012. At this time:*

- D block allocated to public safety
- Over $7 billion in Federal funding
- NTIA assembling FirstNet board
- LTE *required* for the public safety network
- Non-public safety users can have secondary network access
- Partnerships explicitly provided in new law
- Several US carriers advertising commercial 4G service (top two Verizon, AT&T with LTE; T-Mobile, Sprint building out LTE)

# Project Purpose

## Project Overview

- To define need for technical and operational requirements for public safety in Minnesota
- Determine proper technical approach that best meets these problems
- Explore available options
- Develop financing options

# Project Purpose

## Key Issues

- To the greatest extent possible, to leverage investment into ARMER
- Commitment to standards-based approaches
- “Strong feeling” (at the time) that the future network must be compatible with LTE
- Necessary to explore cost efficient options
- Interest in a public/private partnership

# Project Methodology

# Project Methodology

## Consultant Report

- Televate hired as consultant to assist in development of report. This firm was chosen for its extensive experience, specifically for its role in securing LA-RICS BTOP funding.
- State develops project steering committee to review deliverables and advise on project direction.
- SRB was consulted mid-way to advise on project direction. Presentation done August 2011.
- Final deliverable finished March 2012.

# Project Methodology

<u>Originally conceived for two purposes:</u>

- Develop a detailed understanding of actual needs
- Preparation ultimately leading to grant funding request (e.g., BTOP)

- Between 2010 and 2012, the national model changed significantly.
- It is now unlikely that states will lead their own buildout, and either way, it is all part of the national network.
- Changes in legislation and national thinking shifted direction of report; esp. “D Block” bill February 2012.

# Project Methodology

## Deliverables

- User Needs Assessment: May 2011
- Carrier Assessment: July 2011
- Network Requirements Statement: August 2011
- Implementation Model: February 2012
- **Financial Model: March 2012**

# Findings

# Findings

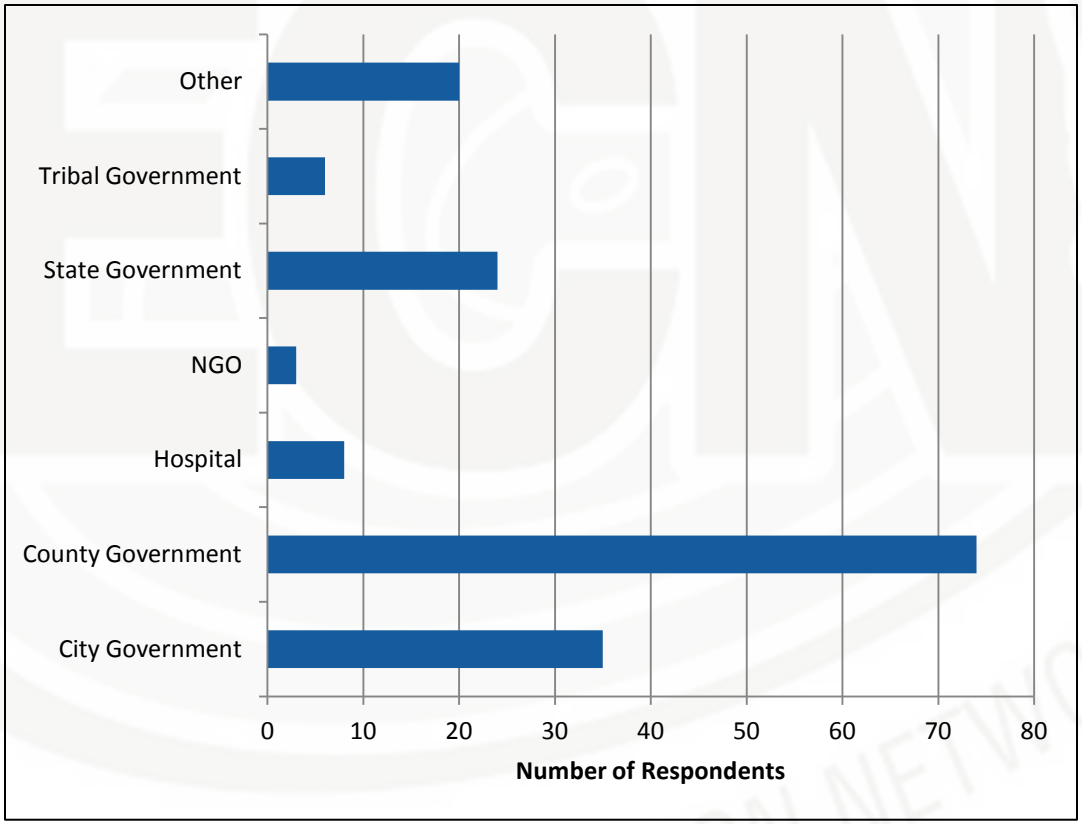
## Section 1: User Needs Assessment

Data collected through:

- Face-to-face interviews (hundreds of man-hours' worth)
- Online survey (175 respondents)

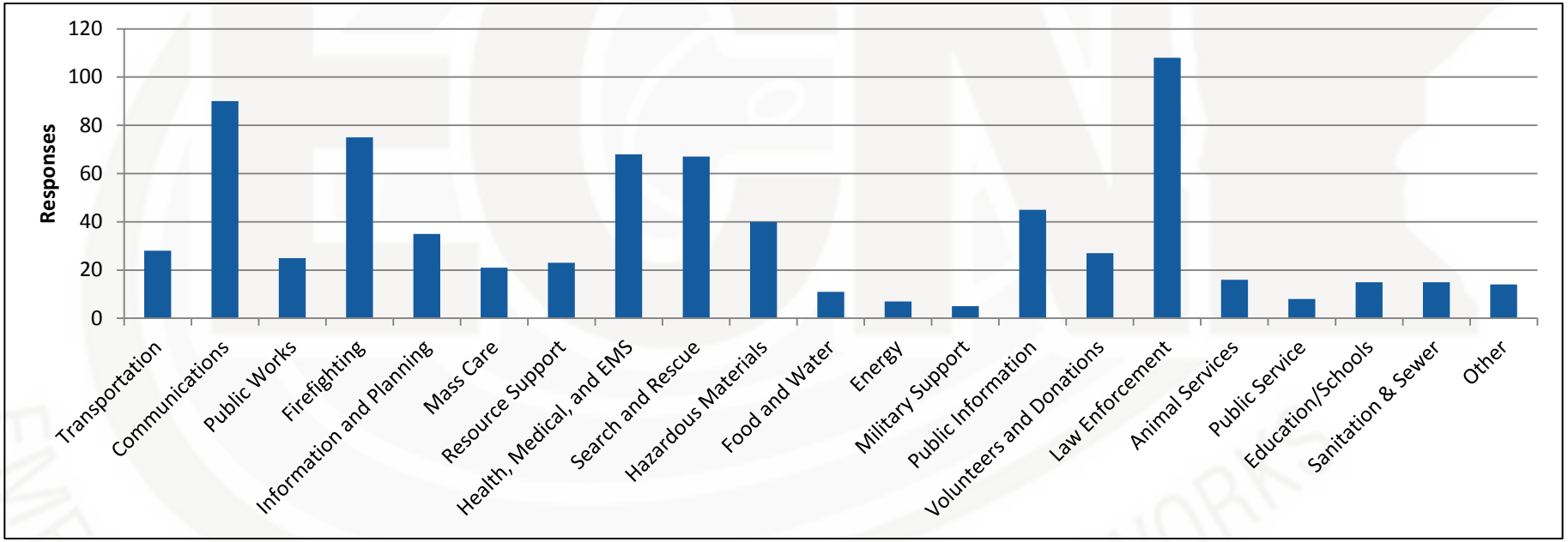
# Findings

## Survey Responses by Organization:

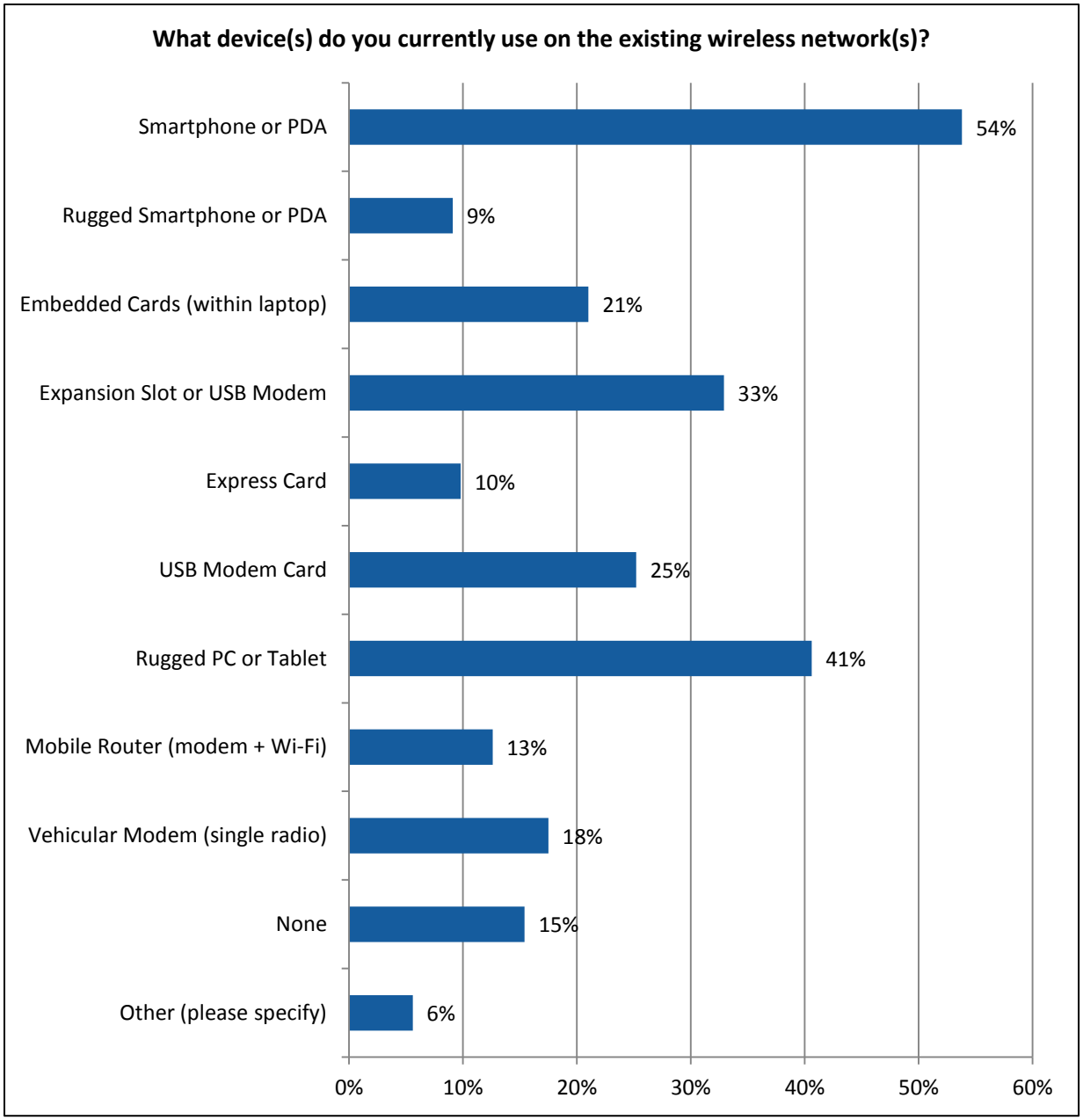


# Findings

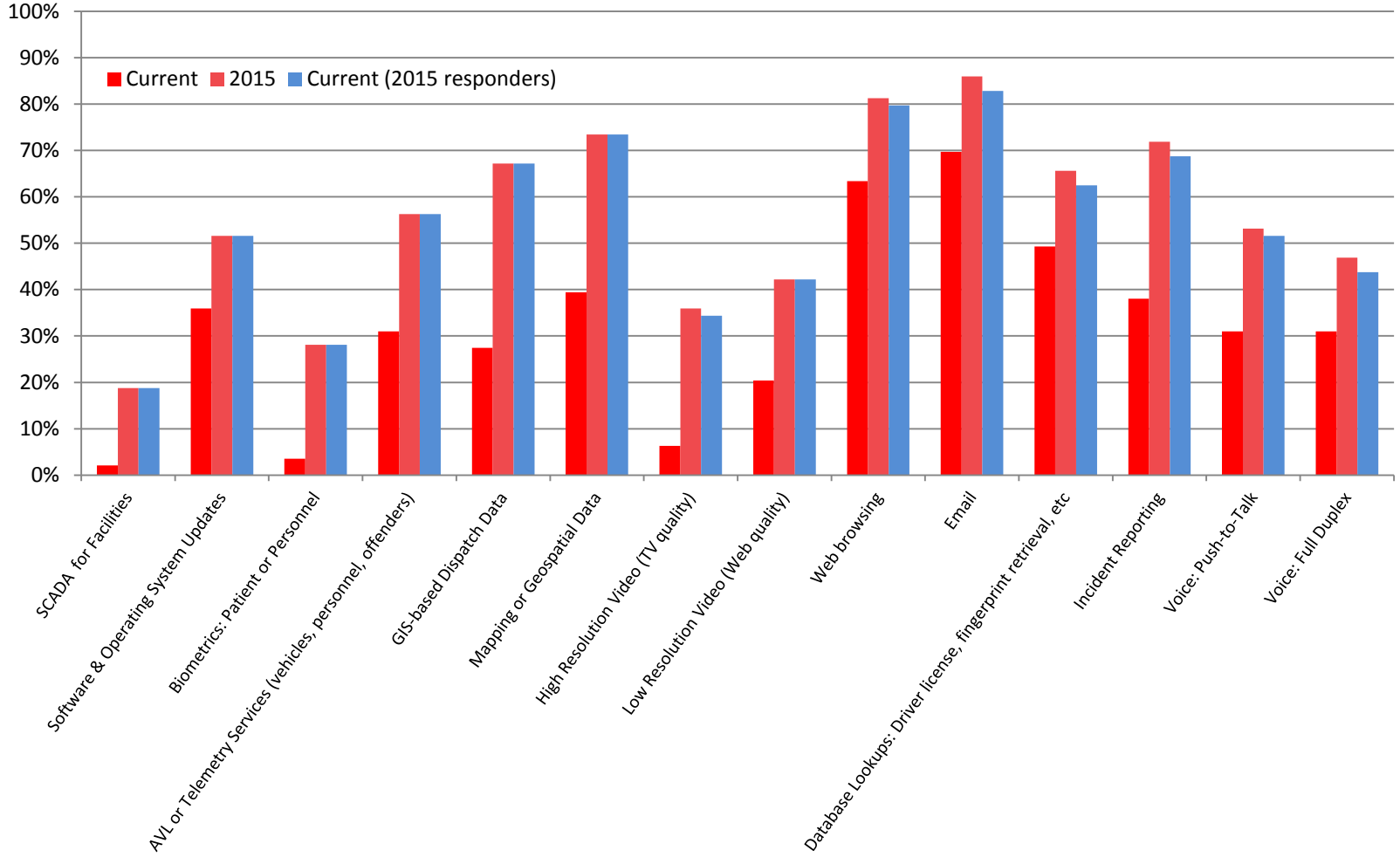
## Survey Responses by Profession:



# Devices:


What device(s) do you currently use on the existing wireless network(s)?
Smartphone or PDA
54%
Rugged Smartphone or PDA
9%
Embedded Cards (within laptop)
21%
Expansion Slot or USB Modem
33%
Express Card
10%
USB Modem Card
25%
Rugged PC or Tablet
41%
Mobile Router (modem + Wi-Fi)
13%
Vehicular Modem (single radio)
18%
None
15%
Other (please specify)
6%
0%
10%
20%
30%
40%
50%
60%

# Applications:

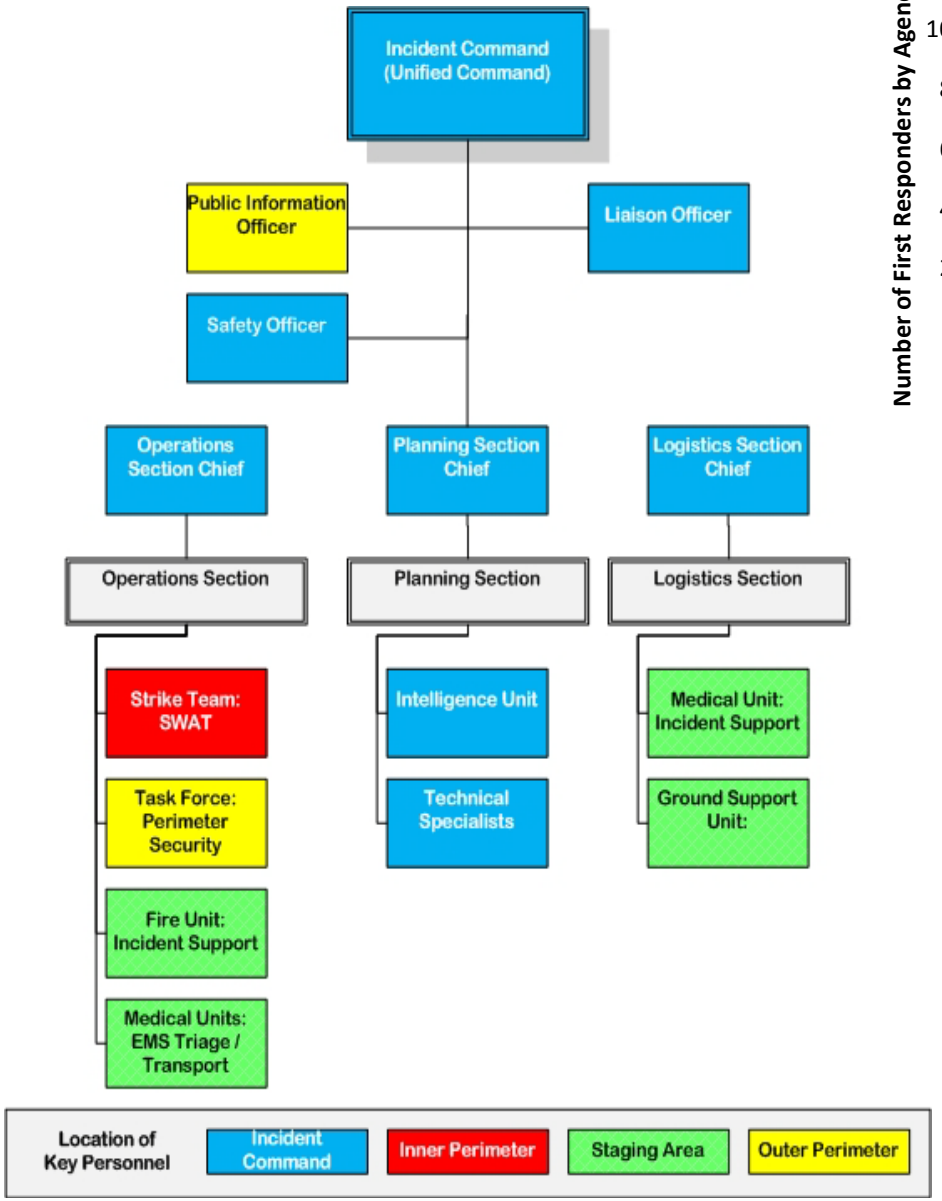


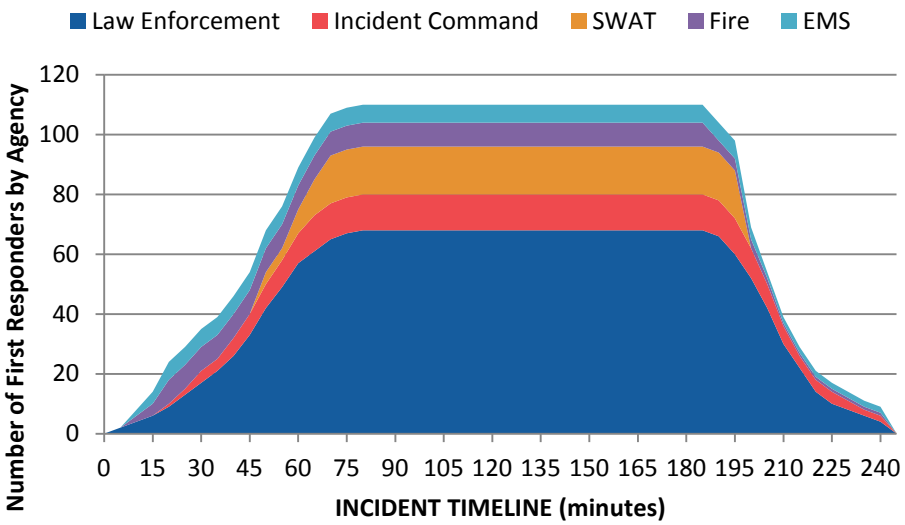
# Findings

## Service Area:

- Existing carrier coverage is not ubiquitous, many rural areas without service,
  - 85% of respondent reported coverage problems
- Expectations:
  - Priority must be to provide 95% mobile coverage on County-by-County basis
  - In-building coverage to be a growing requirement
  - Must have quicker coverage augmentation solutions available for emergencies; COWs, COLTs, Satellite, etc.

# Incident Modeling:



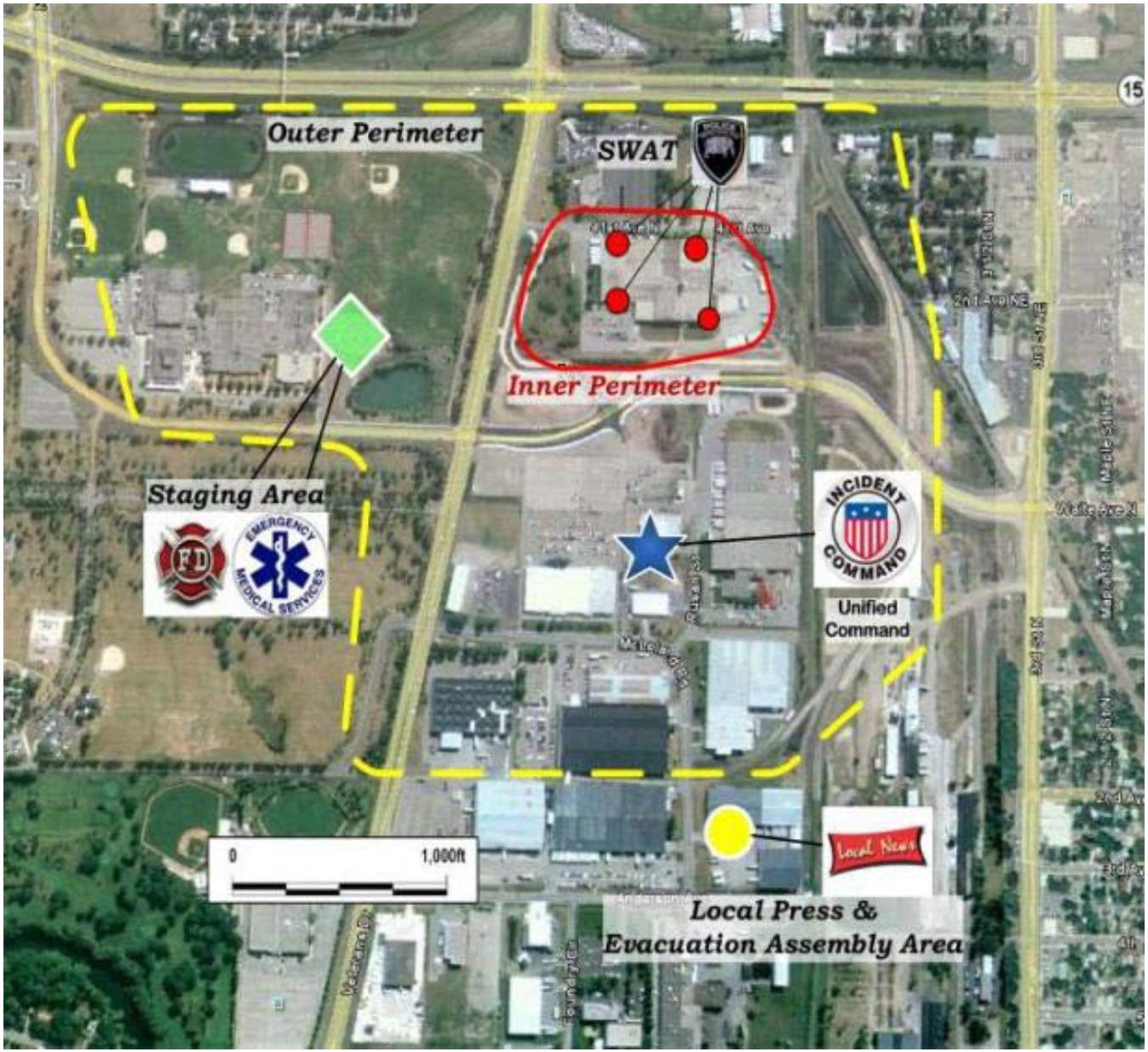



# Findings

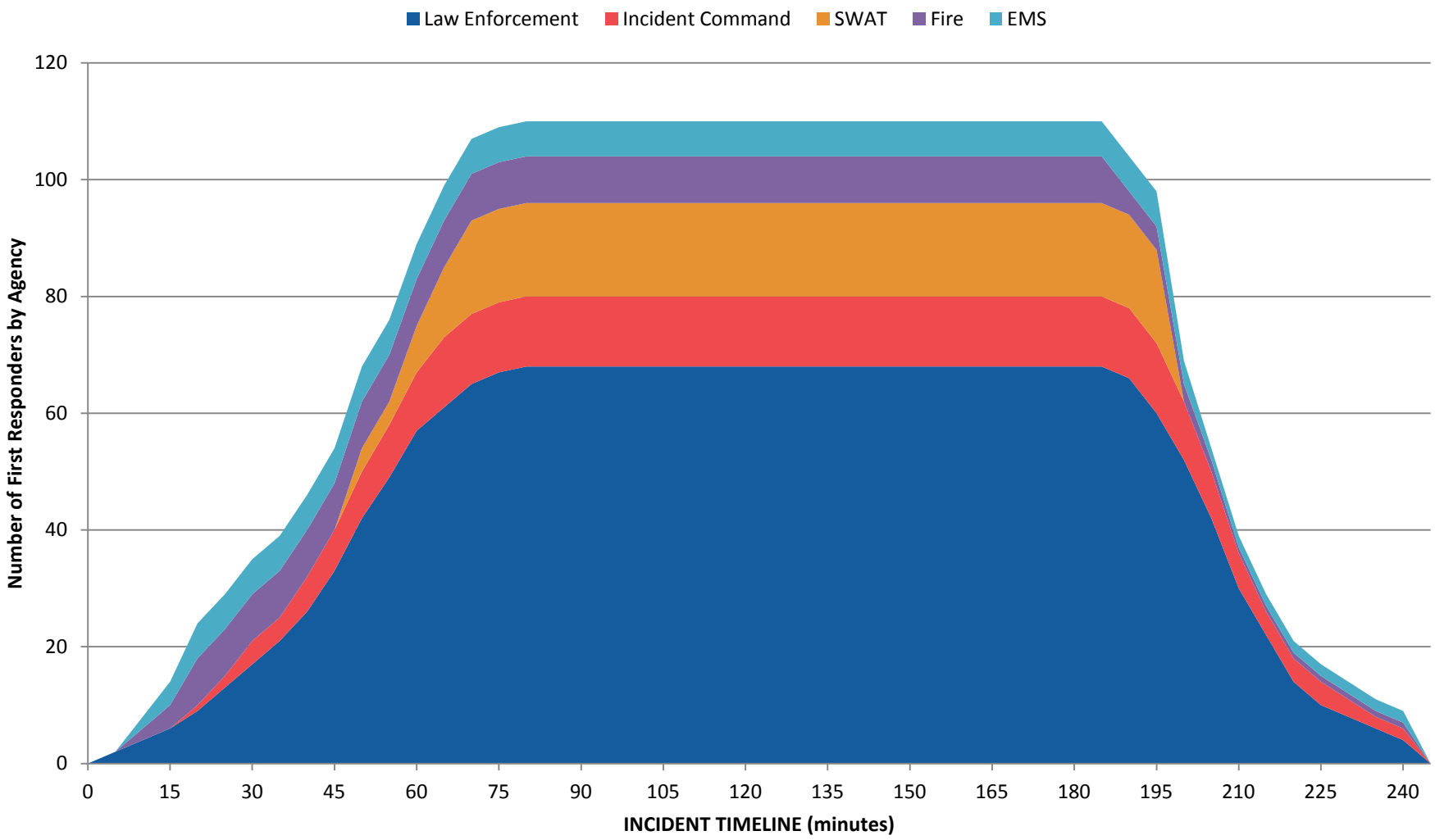
## Incident Model:

- Designed for a high-impact incident that would occur within a small area
- Setting: High School building (2000 students)
  - Approx ½ square mile campus
  - Would be covered by 1-3 sectors
- Scenario: Active shooter to hostage situation
- Modeled according to ICS with table-top exercises (including public safety, transit, county government, military)

# Incident Area:



# Number of responders:



# Findings

## Stats:

| | PEAK Uplink | PEAK Downlink | Average Uplink | Up % | Average Downlink | Downlink % |
|---|---|---|---|---|---|---|
| **Strike Team Subtotal:** | 2856 kbps | 492 kbps | 2667 kbps | 62% | 303 kbps | 4.0% |
| **Unified Command Subtotal:** | 1106 kbps | 10009 kbps | 427 kbps | 10% | 6524 kbps | 86% |
| **Staging Area Subtotal:** | 1044 kbps | 609 kbps | 947 kbps | 22% | 513 kbps | 7% |
| **Perimeter Subtotal:** | 257 kbps | 256 kbps | 257 kbps | 6% | 256 kbps | 3.4% |
| **INCIDENT TOTALS:** | **5263 kbps** | **11366 kbps** | **4298 kbps** | | **7596 kbps** | |

- Peak Traffic: 11,366 DL / 7596 UL kbps
  - Or, approximately one completely maxed out 10x10 MHz LTE sector
- Uses multicast/broadcast for traffic efficiency
- Does not include mission-critical push-to-talk
- At the time, showed we do not have enough spectrum for an incident. We do now with the D Block.

# Findings

## Other Notes:

| Scenario | Average Uplink (kbps) | Average Downlink (kbps) | Percentage Video (UL/DL) |
|---|---|---|---|
| Present / Urban | 623 | 3,849 | 26%/60% |
| Present & Future Rural | 197 | 2,509 | 41%/61% |
| Future / Urban | 4,298 | 7,596 | 74%/77% |

**Speed Comparisons:**

Dial-up: 56 kbps

Project 25: 9.6 kbps (per-channel)

DSL: 1,500 / 256 kbps (down/up)

Cable Modem: 3,000 / 756 kbps (down/up)

*Study document includes separate figures for urban, rural, present, future scenarios*

# Findings

## Section 2: Network Requirements

- A statement of basic technical requirements that would form the basis of an RFP specification
- Includes detail on coverage, throughput, features, security, etc.

# Findings

## General Requirements and features

- Leverage existing assets as much as possible, i.e. ARMER Towers
- Comply with NPSTC, FCC/ERIC/PSAC, 3GPP standards, Band class 14 and future LTE features: eMBMS, LIPA, SIPTO, SON, CoMP
- Support State applications identified in User Needs Assessment

## Network Reliability / Survivability

- Public Safety grade, no single point of failure
- Dual hardened, geographically separate Evolved Packet Cores,
- Dual path redundant backhaul

# Findings

## Security

- Federal Information processing Standards (FIPS 140-2, level 1 minimum)
- Security policies implemented by each individual agency

## Height Assumptions:

- Below ARMER antenna height
- New Site Height: Rural: 250ft, Metro: 150ft

## Other

- Dynamic Prioirity, Pre-Emption
- Text Messaging
- Roaming with other networks (public safety and commercial)

# Findings

## Coverage Requirement:

| Coverage Requirement | Area Description | UL Rate | DL Rate |
|---|---|---|---|
| 95% In-Building | Metropolitan areas | 256 kbps | 933 kbps |
| 95% Outdoor Handheld | Metro counties (inc. St. Cloud) | 256 kbps | 1437 kbps |
| 95% Mobile | Statewide County-by-County | 256 kbps | 1437 kbps |

**Speed Comparisons:**

Dial-up: 56 kbps

Project 25: 9.6 kbps

DSL: 1500 / 256 kbps

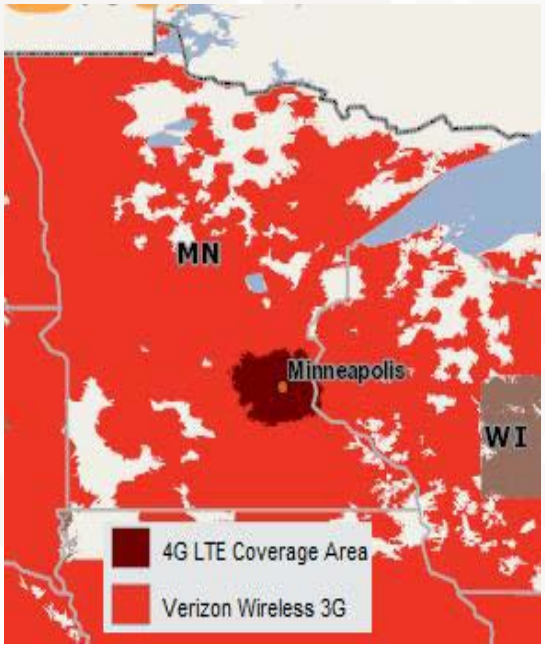
Modem: 3000 / 756 kbps

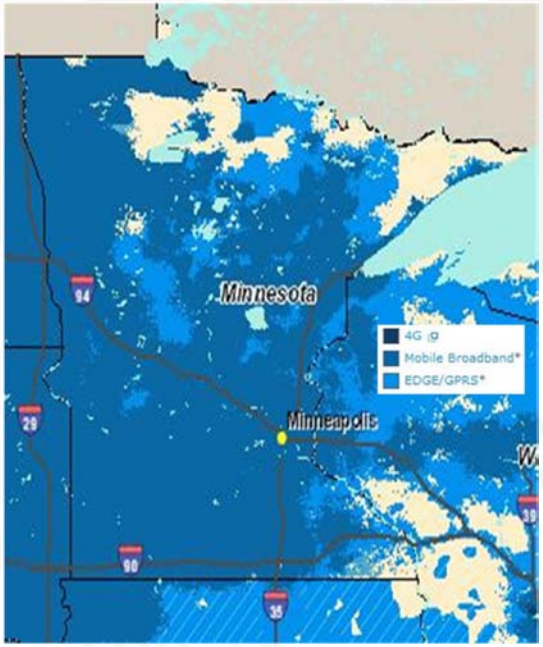
| Scenario | Av UL | Av DL | % Video |
|---|---|---|---|
| Present Urban | 623 | 3,849 | 26%/60% |
| Rural | 197 | 2,509 | 41%/61% |
| Future / Urban | 4,298 | 7,596 | 74%/77% |

# Findings

## Section 3: Carrier Assessment

- Consulted with carriers advertising 4G deployments in 700 MHz band (Verizon, AT&T)

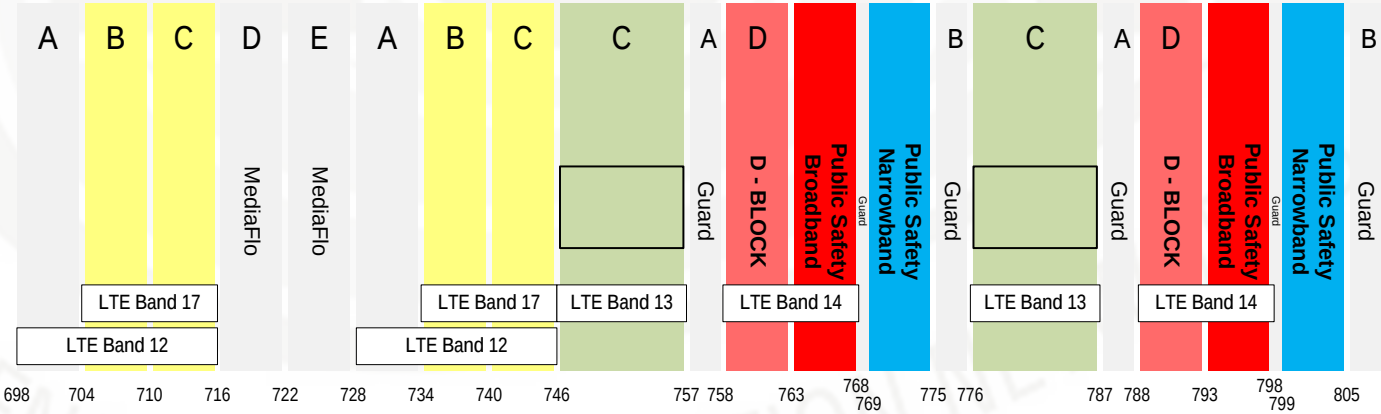


# Findings

## Section 3: Carrier Assessment

- No pre-emptive priority
- No ARMER-level coverage (no commercial benefit)
- Availability approx. 99.5%
- Not public safety-grade on carrier spectrum
- May have option for using public safety spectrum on carrier network (hosted core/leased backhaul)



# Findings

## Section 4: Implementation Model

- Options considered ranging the entire spectrum
- Budgetary design based on state-funded buildout
  - Most expensive (worst-case)
  - Baseline to negotiate and plan from ("bring it down")

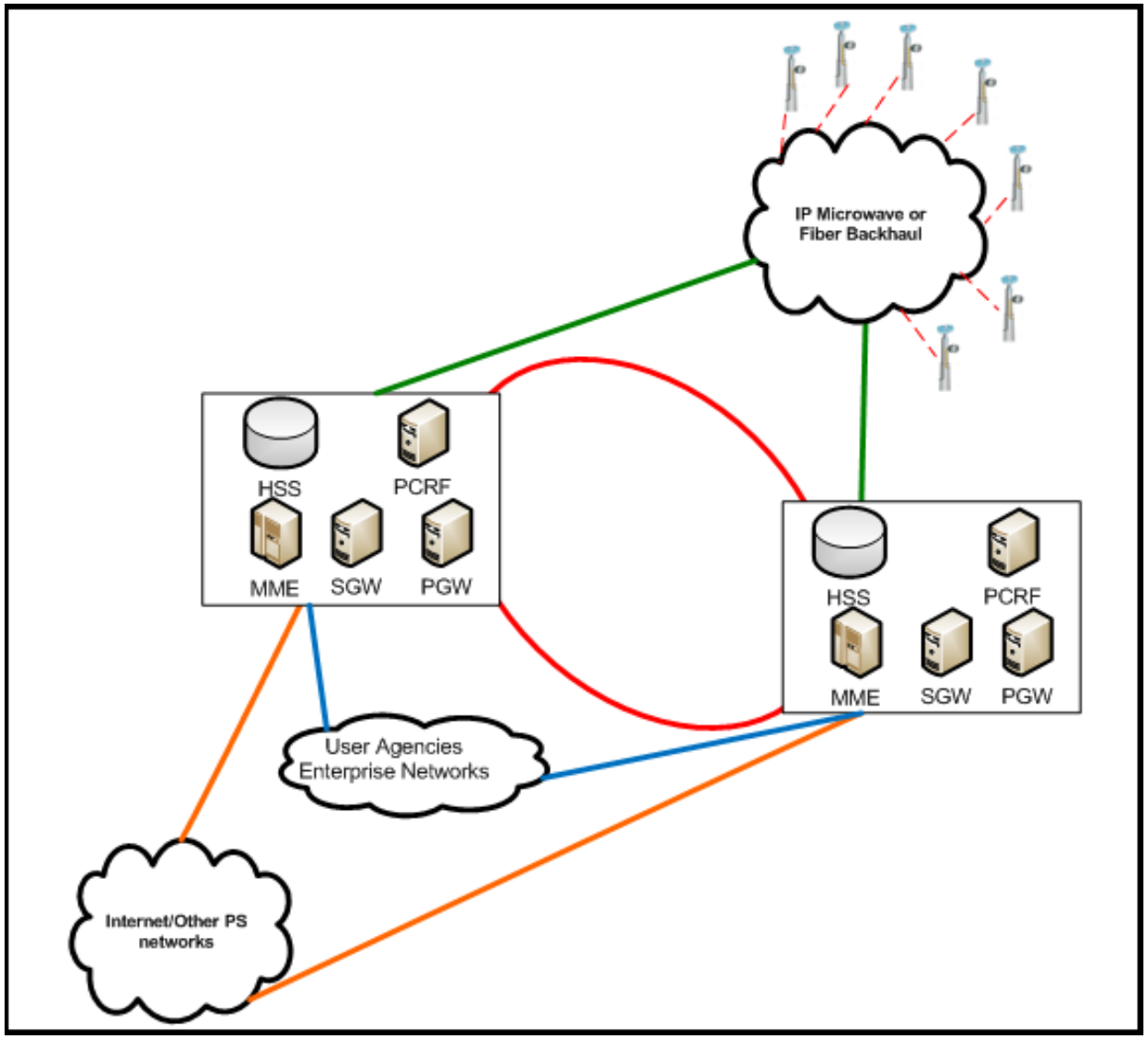
| Model | Description |
|---|---|
| Private Service | Completely Private Solution (could be DBOM by 3rd party) |
| Public / Private Partnership | Leverages assets of commercial carriers |
| Commercial Service | Commercial carrier DBOM system |

# Findings

## Section 4: Implementation Model

| Model | Description | Advantages | Disadvantages |
|---|---|---|---|
| Private Service | Completely Private Solution (could be DBOM by 3rd party) | State controls requirements and priorities (public safety grade, pre-emption) | Highest capital cost |
| Public / Private Partnership | Leverages assets of commercial carriers | Reduced capital costs, balanced requirements versus capital | Unknown operating costs, potentially unmet requirements |
| Commercial Service | Commercial carrier DBOM system | No capital costs | High risk of unmet requirements |

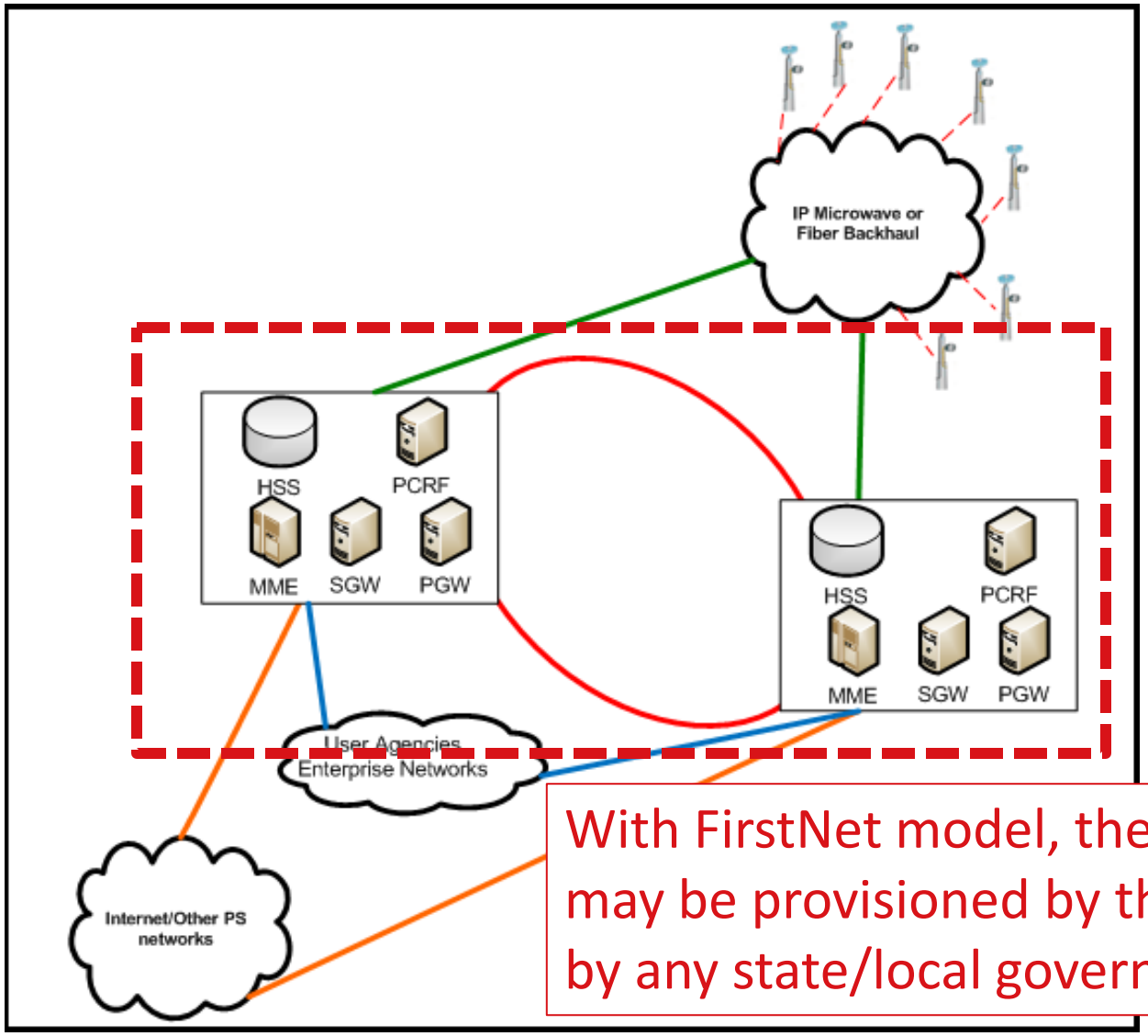
# Core Functions:



"cell site"
eNodeB

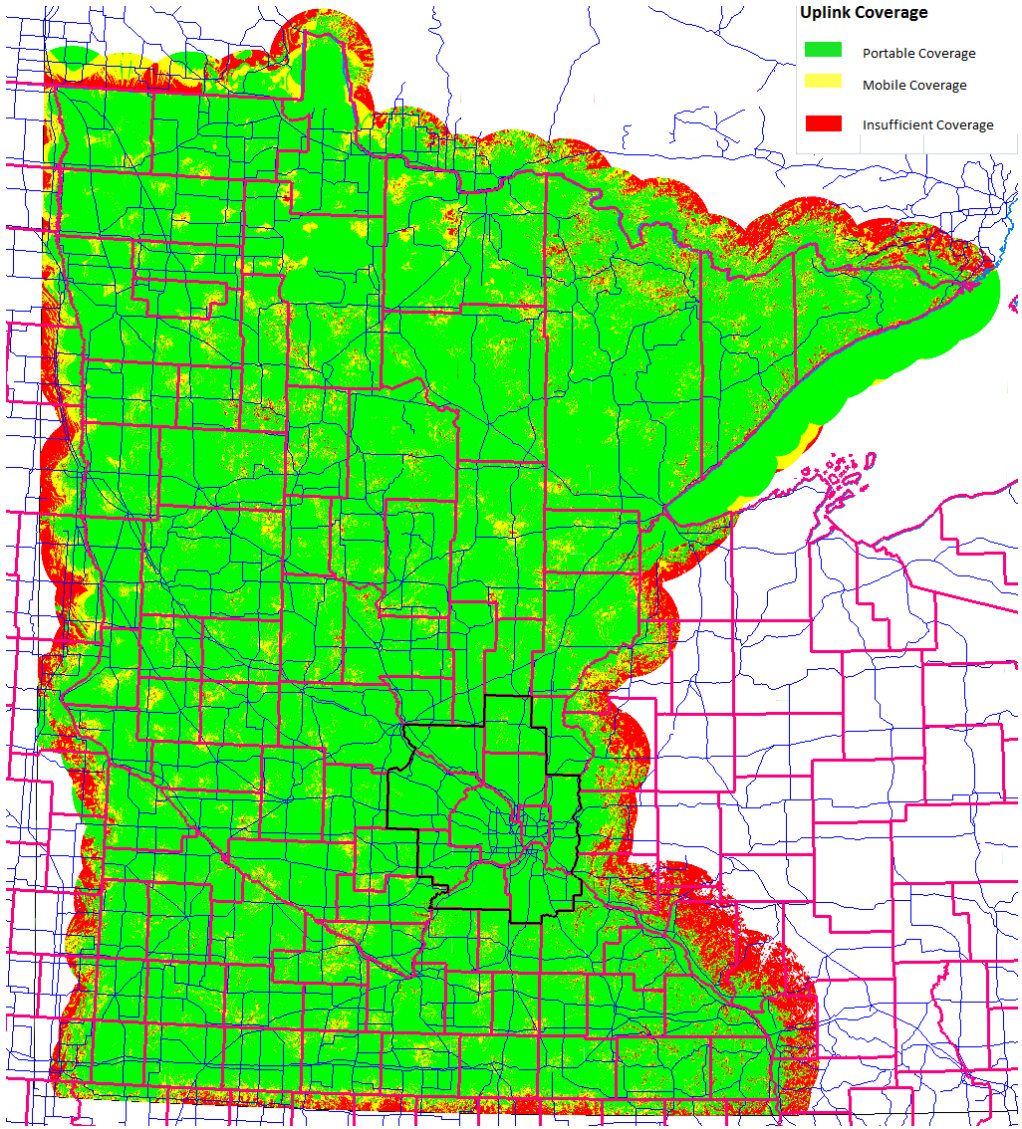
Microwave

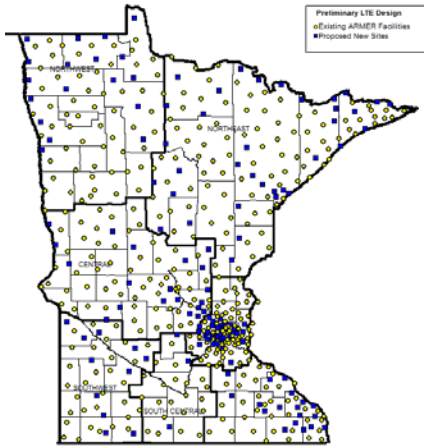
# Core Functions:




With FirstNet model, these “core” services may be provisioned by the Fed; not owned by any state/local government.

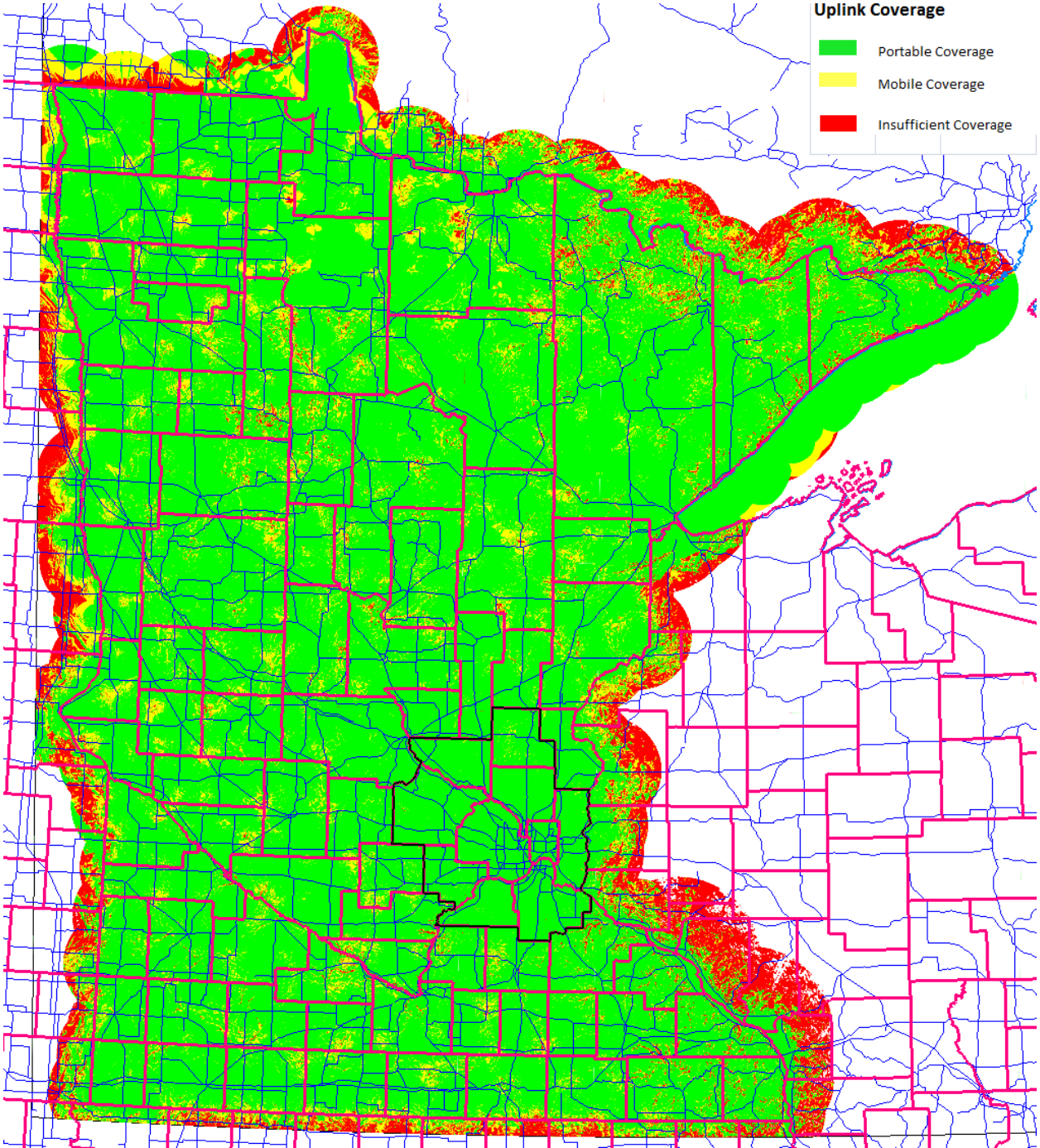
# Preliminary Network Designs: "ARMER PLUS"



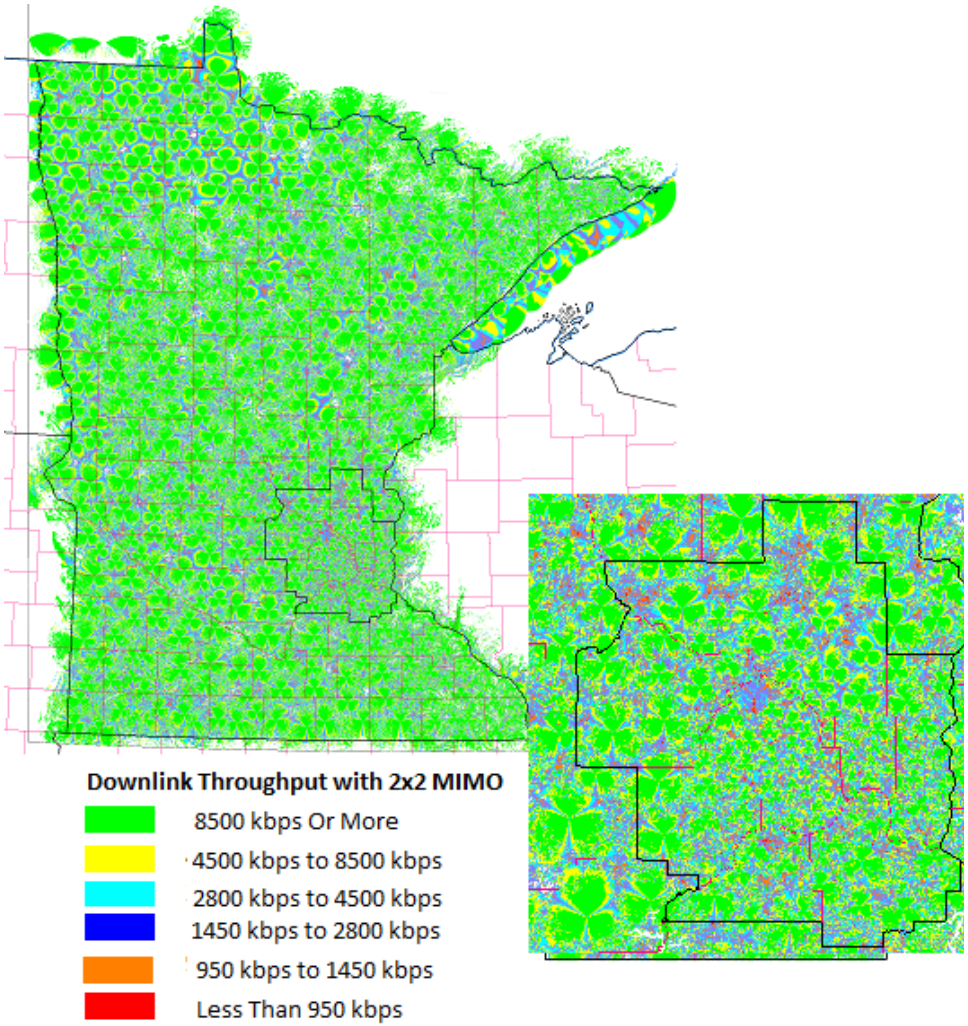




| Region | ARMER Sites | New Sites | Total | % New |
|---|---|---|---|---|
| **Central** | 63 | 20 | 83 | 24% |
| **Metro** | 70 | 36 | 106 | 34% |
| **Northeast** | 97 | 35 | 132 | 27% |
| **Northwest** | 59 | 18 | 77 | 23% |
| **South Central** | 20 | 3 | 23 | 13% |
| **Southeast** | 39 | 18 | 57 | 32% |
| **Southwest** | 32 | 11 | 43 | 26% |
| Total | **380** | **141** | **521** | **27%** |

521 sites to meet all requirements

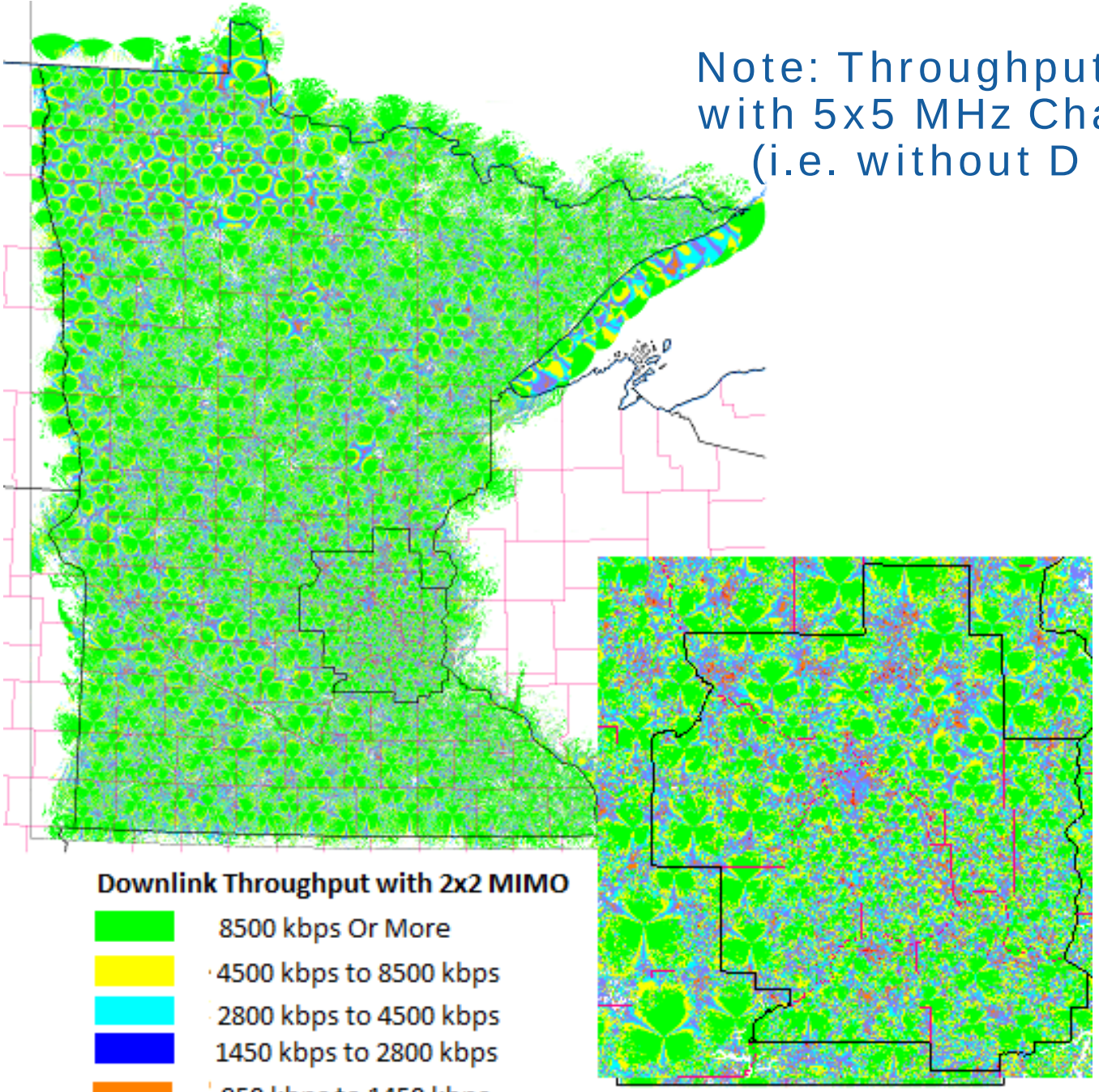

Uplink Coverage
Portable Coverage
Mobile Coverage
Insufficient Coverage

# Actual Throughput

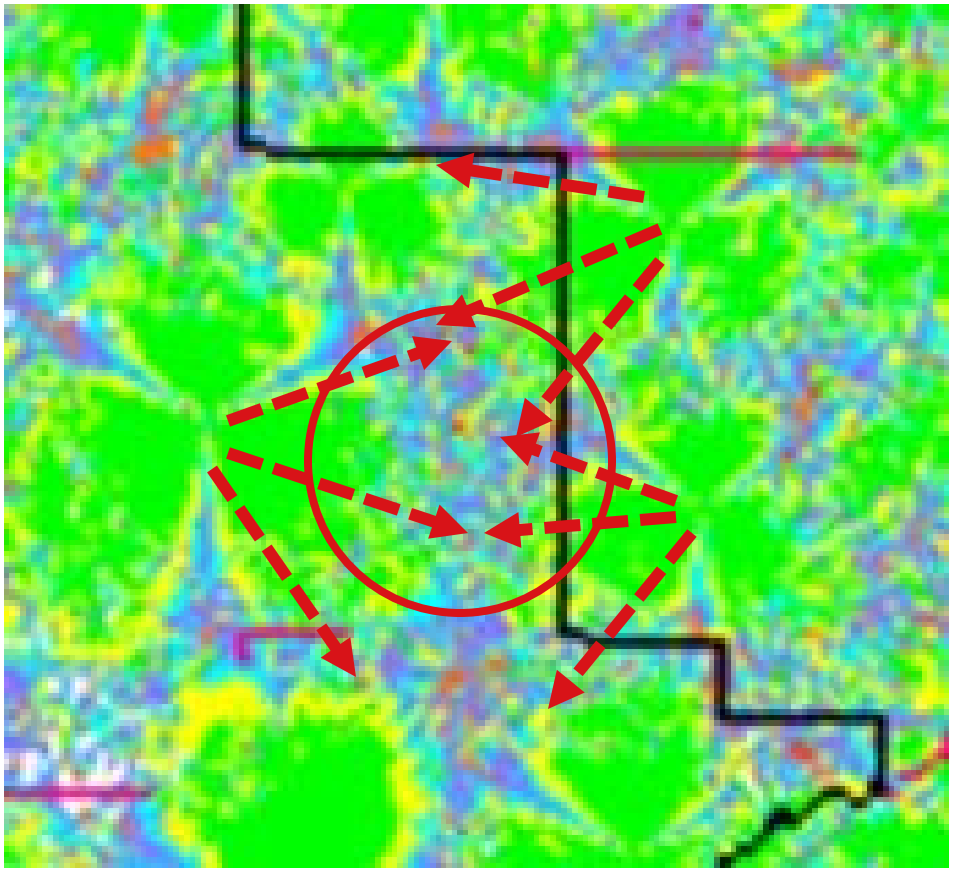



- Actual LTE throughput at each site can be as high as 8500 kbps with 5x5 MHz; double that with 10x10 MHz
- Various factors degrade actual throughput, so statewide requirement is actually a fraction of peak performance
- Sectors are unlikely to perform at peak performance most of the time for technical reasons (adaptive modulation, intra-system interference, others)

Note: Throughput rates with 5x5 MHz Channels (i.e. without D Block)



# “Overlapping” Coverage in LTE and intra-system interference:



LTE uses same channel at every site (CDMA/OFDM modulation)

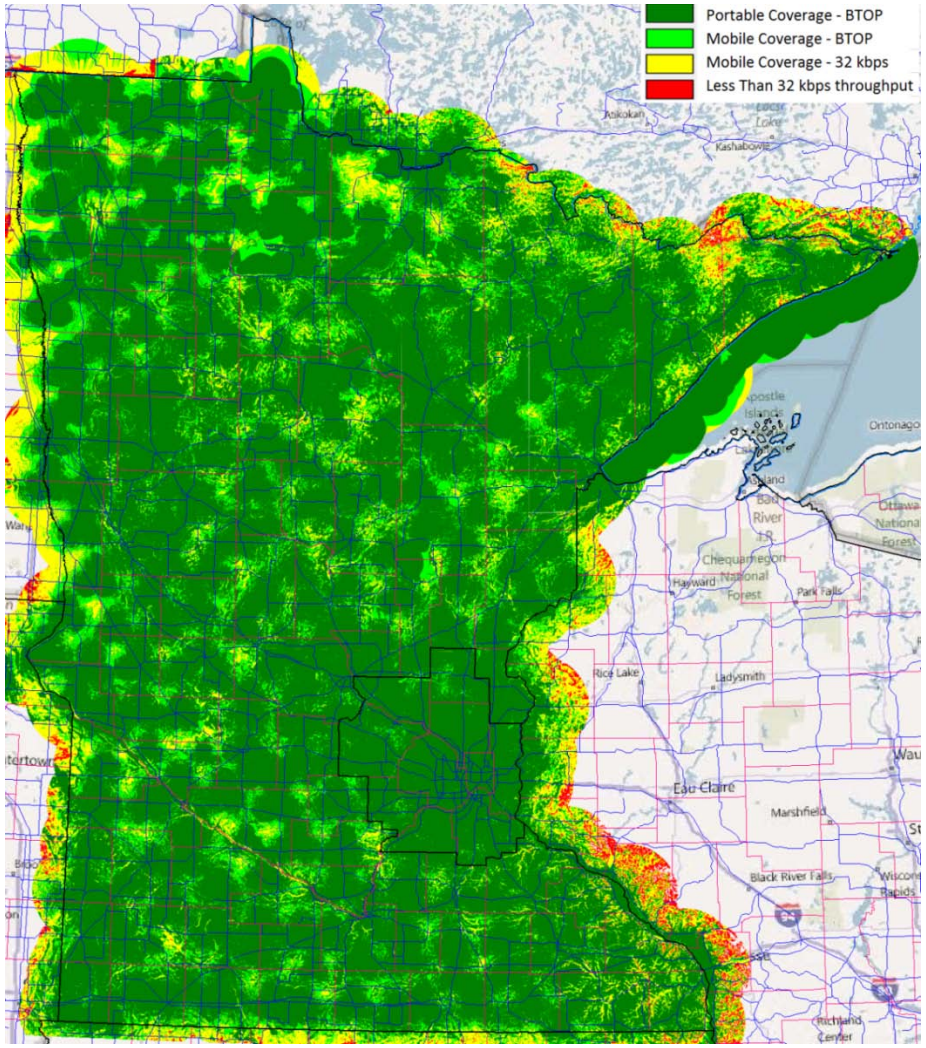
Cells can interfere with each other at the edge

LTE sites normally mitigate interference

If multiple sectors are at peak capacity, they may interfere with each other

At the intersection of sectors, throughput drops to 1450 kbps, or 17%

# Preliminary Network Designs: "ARMER" 380-site Transitional Design

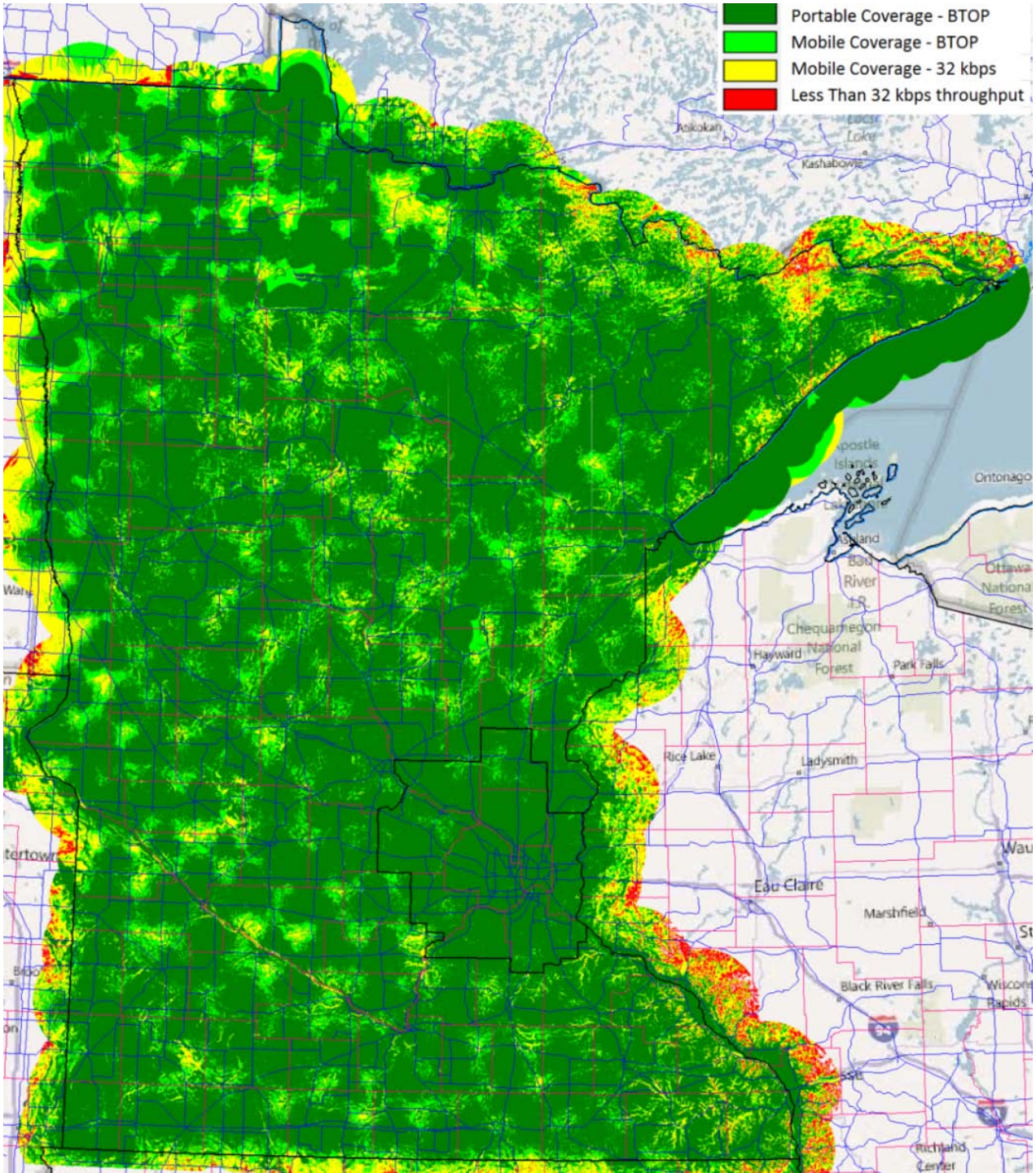



ARMER Only – Broadband Speed

- Avoids 141 tower builds
- 94% statewide mobile coverage (lt. green)
- 28 counties < 95%, E.G.,:
  - Cook: 78%
  - Winona: 82%
  - Lake of Woods: 86%
  - Lake: 82%

ARMER Only – Dial-up Speed

- LTE can scale down to lower rates in the yellow areas
- > 95% statewide coverage
- 4 counties < 95%:
  - Cook: 92%
  - Winona: 93%
  - Lake of Woods: 91%
  - Lake: 94%


Portable Coverage - BTOP
Mobile Coverage - BTOP
Mobile Coverage - 32 kbps
Less Than 32 kbps throughput
Atikokan
Kashabowie
Ontonagon
Bad River IR
Ottawa National Forest
Chequamegon National Forest
Hayward
Park Falls
Rice Lake
Ladysmith
Eau Claire
Marshfield
Black River Falls
Richland Center

# Findings

## BUDGETARY Baseline Costs:

- "ARMER PLUS" model meets all needs
- Transitional "ARMER" model meets all needs in only a few areas
- Assumptions built-in; intended to be accurate enough for funding proposals; contingency dollars included

| Expenditures | ARMER PLUS (521 Sites) | ARMER (380 Sites) |
|---|---|---|
| **Radio Access Network (RAN) and Backhaul** | $ 310,717,004 | $ 182,828,703 |
| **Core Network** | $ 21,419,800 | $ 19,994,200 |
| **Total Capital** | $ 332,136,804 | $ 202,822,903 |
| **Annual Operational Expenditures** | $ 14,078,275 | $ 13,077,350 |

# Findings

## "OET ARMER" Model:

- Maximizes use of municipal/county fiber projects and state OET network for backhaul
  - i.e., less microwave
  - Budgetary pricing from OET based on presumption of SLAs
- Reduces CAPEX (6%) but increases OPEX (12%)
  - 10-year OPEX increase of about $18M for both 521/380 sites
  - CAPEX savings of about $17.5M for both 521/380 sites

| Expenditures | OET ARMER PLUS | OET ARMER |
|---|---|---|
| **RAN and Backhual** | $ 293,324,458 | $ 165,436,156 |
| **Core Network** | $ 21,419,800 | $ 19,994,200 |
| **Total Capital** | $ 314,744,258 | $ 185,430,356 |
| **Annual Operational Expenditures** | $ 15,910,930 | $ 14,910,005 |

# Findings

## Section 5: Financial Models

- Three models covered
- To range the gamut from fully state-owned (like ARMER; “opt-out” scenario) to carrier-owned

| Model | Description |
|---|---|
| **State Public Model** | The State builds, owns, operates, and maintains the network. This is analogous to land-mobile radio deployment in the past, such as ARMER. |
| **Vendor-Financed Model** | A vendor fills in financial shortfall for building and operating the network by making commercial usage available to the network. |
| **Commercial Carrier Model** | An existing carrier augments it network to meet public safety needs. |

# Findings

## Section 5: State Public Model

- Fully state-owned and operated; the “ARMER” model
- “Opt-out” scenario per recent legislation
- Costs and impacts per Implementation model
- State will still have to pay spectrum lease fees to FirstNet
- State will *probably* still have to pay network core services fees
- State will *probably not* need to build a core.
- State is expressly prohibited from selling commercial service. May do so through a private partner.

# Findings

## Vendor-Financed Model

- Vendor-owned/operated; "Bay-RICS", Motorola model
- Vendors will have to incorporate financing costs into their fees; may double annual OPEX
  - Note: Cost of money is very low today; may change over time
- Vendor *is not* prohibited from selling commercial access to subsidize the cost of network

**Sample private financing costs:***

| | |
|---|---|
| Loan Amount | $173,250,653 |
| Loan Term | 10 Years |
| Annual P&I Payment | $21,895,213 |
| Net Total Interest | $45,701,481 |

*: Vendor capital based on study CAPEX Minus $120 M (anticipated FirstNet funding for Minnesota)

# Findings

## Commercial Carrier Model

- 100% carrier service using carrier devices
- Assumes commercial devices and RAN equipment will be modified to support public safety spectrum
  - Buying power of national public safety market makes it feasible
  - Currently, devices do not support public safety spectrum
- State to make investments to augment carrier network to meet its requirements
- Based on study findings, 99% of time, in 99% of the area, public safety utilization of the network in Minnesota is 10-40% at any point in time
  - Excess capacity could be used by commercial devices

# Findings

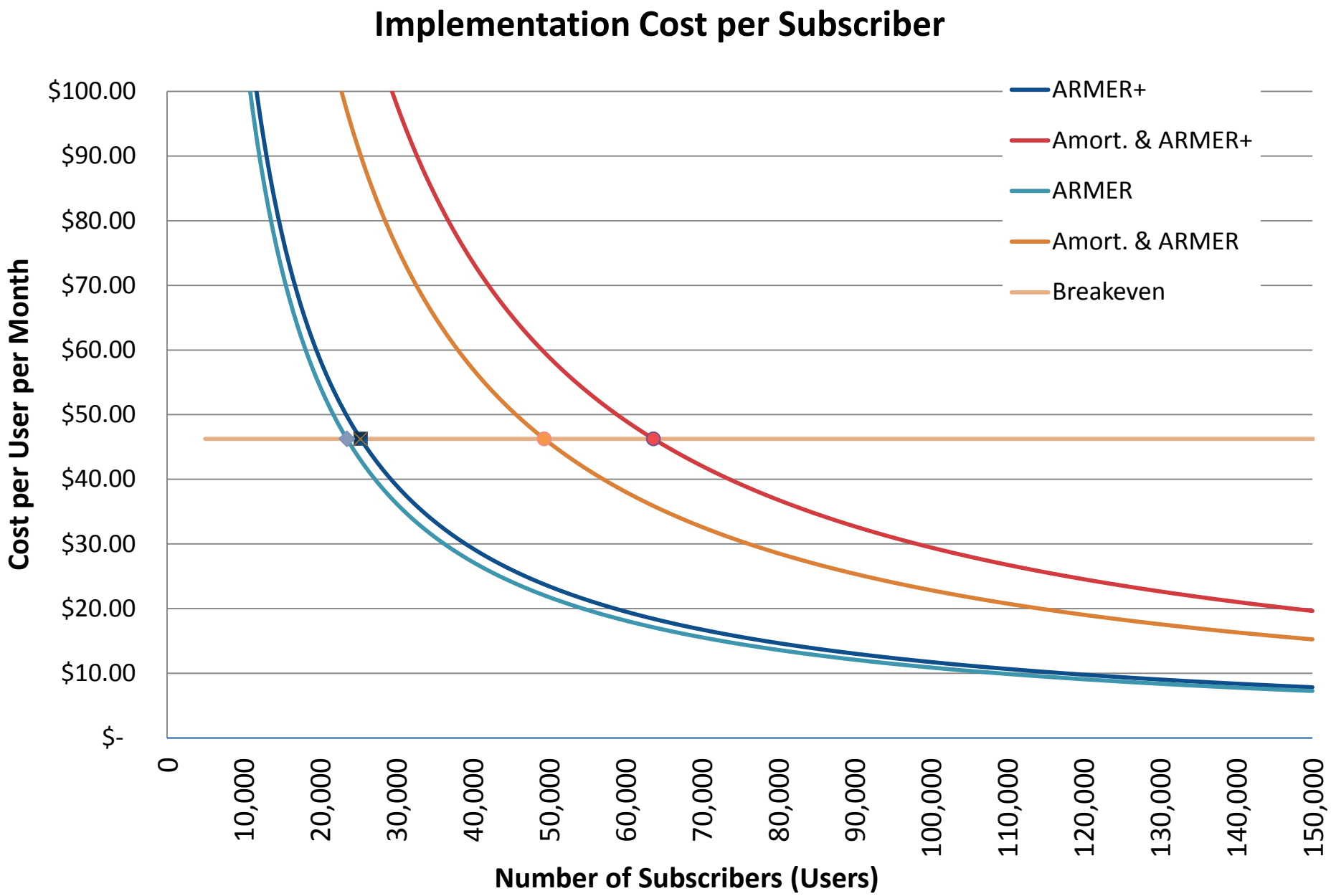
## Capital Funding:

- Almost Certain: FirstNet funding, $7 Billion appropriation
  - Based on population and geography, Minnesota could expect $20-$120M)
- Likely: State/Local Implementation Grant Program ($100 M)
- Possible: Local Funding (e.g. subsystem projects)
  - Note ARMER, where about 15% of sites are locally-owned
- Possible: Partner funding
  - e.g. rural broadband initiatives, utilities
- Possible: User Fees
  - User fees at about $47/mo and 65,000 users. Would require financing.
- Unlikely: Federal Grants (SHSP, UASI, OPSG, AFG)
  - These programs not likely to be a good source of revenue in the future
- Unlikely: 911 Bonds
  - ARMER bonds mature in 2026. Unpopular option, little political interest.

# Findings

## Operational Funding:

- Likely: Divert spending from commercial services
  - State contracts values at $13 M on cellular services through 2011
  - A portion may be diverted to private state network
- Possible: Partner funding
  - e.g. rural broadband initiatives, utilities
- Possible: Commercial service funding
  - Through a partner, like a cellular carrier
- Possible: User Fees
  - User fees at about $47/mo and 65,000 users
- Unlikely: Additional General Funds
  - Little public appetite for new, major general appropriations
- Unlikely: 9-1-1 Fee Increase
  - A $0.10 per-line increase in 9-1-1 fees could pay OPEX for the network in Minnesota
  - Would require statute revision and broad support


Implementation Cost per Subscriber
Cost per User per Month
$100.00
$90.00
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$-
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
110,000
120,000
130,000
140,000
150,000
Number of Subscribers (Users)
ARMER+
Amort. & ARMER+
ARMER
Amort. & ARMER
Breakeven

# FirstNet and a New National Model

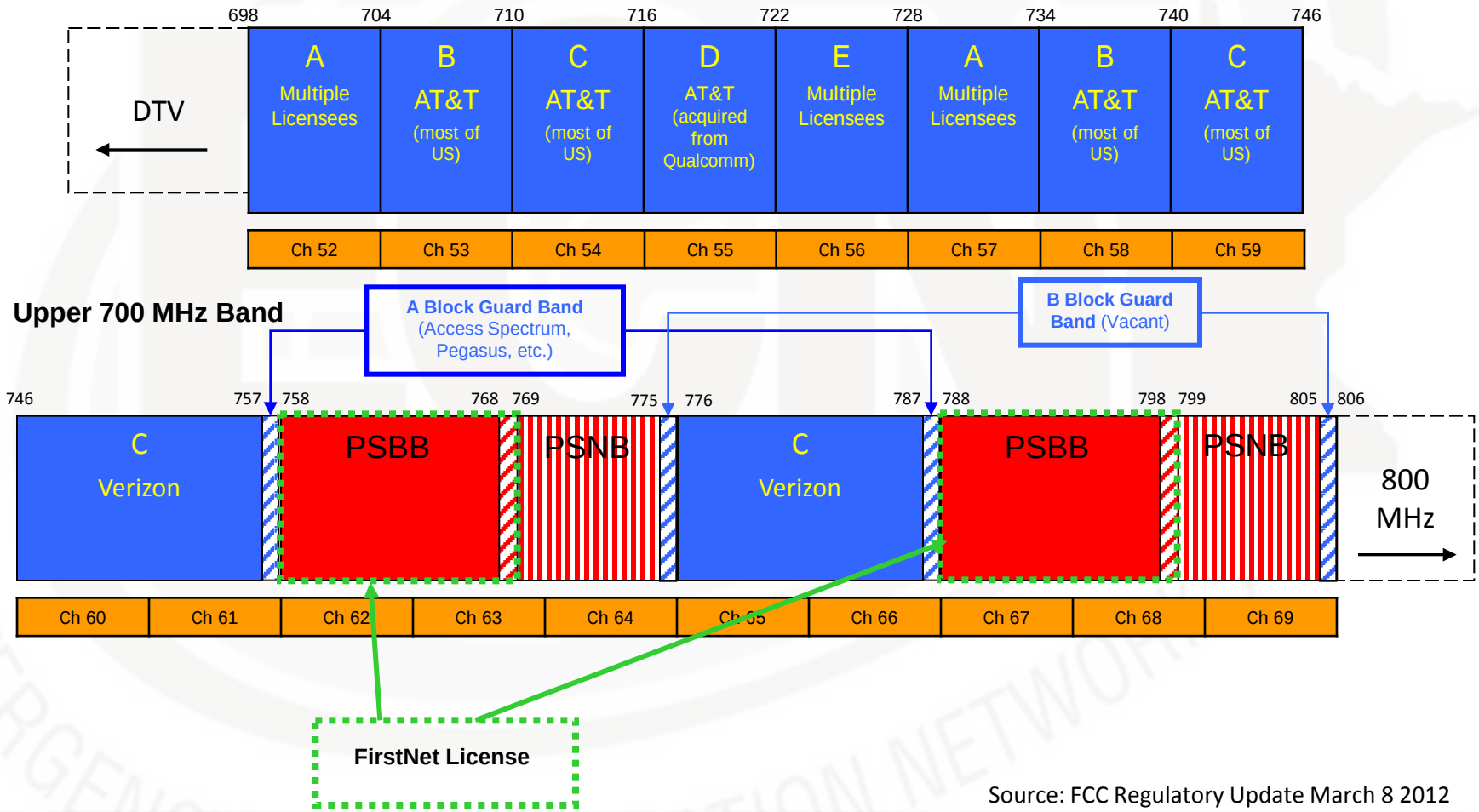
# FirstNet

## 2012 Middle Class Tax Relief and Job Creation Act

- 700 MHz D Block to reallocated to public safety
- First Responder Network Authority (new entity within NTIA) will hold public safety broadband license and be responsible for NATIONAL network deployment and operation
  - FirstNet board of directors will include federal, state, and local representatives (NTIA must appoint state/local members by August 20, 2012)
- Up to $7.3 billion in funding for network from future FCC incentive auctions (NTIA can borrow $2 billion up front)
- States can "opt-out" and deploy state networks (subject to FCC approval)

Source: FCC Regulatory Update March 8 2012

# FirstNet




Source: FCC Regulatory Update March 8 2012

# FirstNet

## Transition

- FCC to transition public safety broadband spectrum to FirstNet
- FCC Technical Advisory Board for First Responder Interoperability
  - Develop technical requirements for broadband interoperability
  - Board recommendations submitted to FCC for review
  - FCC approves Interoperability Board recommendations and transmits them to FirstNet for adoption
- Timing:
  - March 23 -- FCC appoints Interoperability Board members
  - May 22 -- Board must submit recommendations to FCC
  - June 21 -- FCC must transmit recommendations to FirstNet

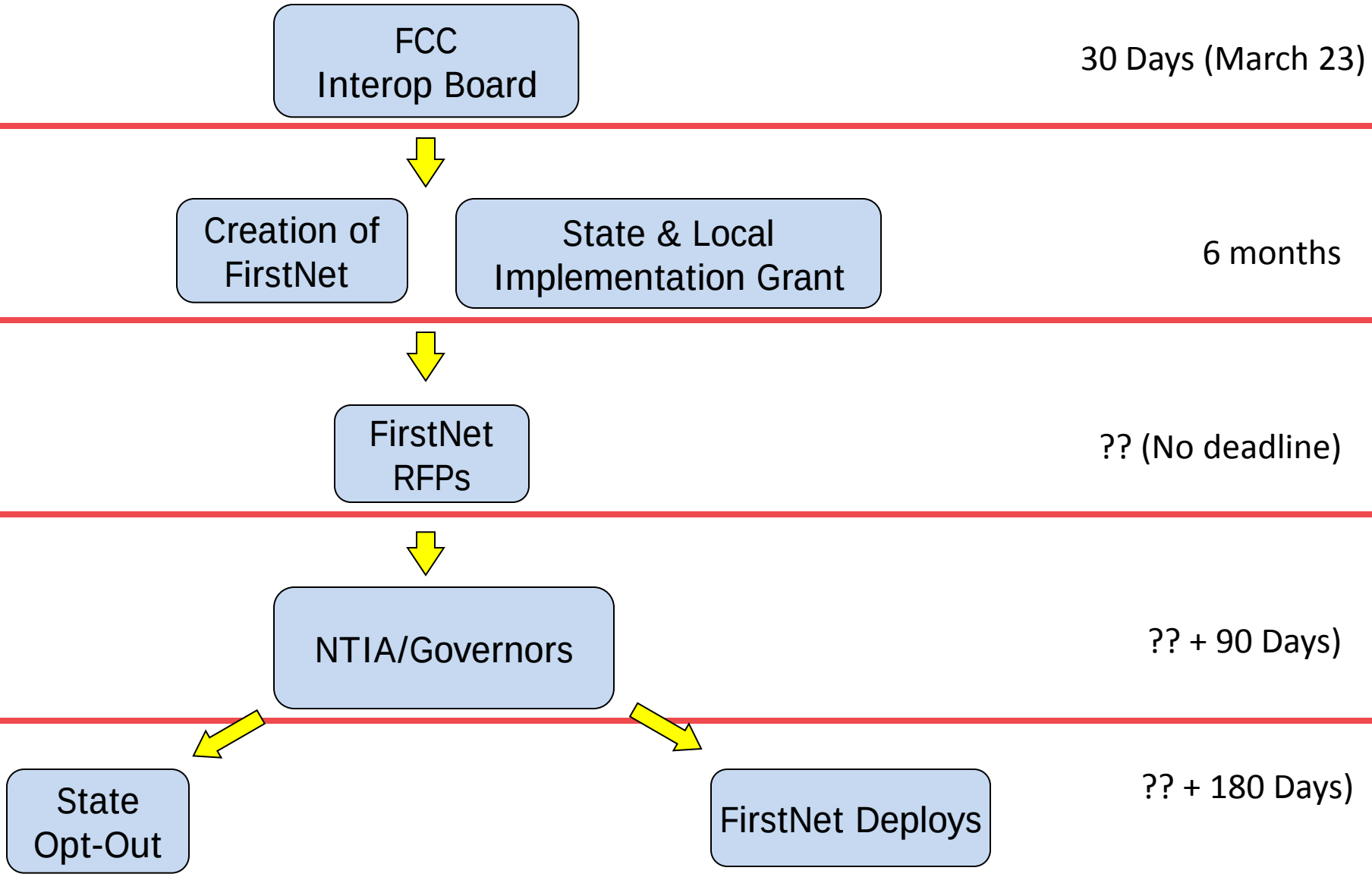
Source: FCC Regulatory Update March 8 2012

## FirstNet Duties and Obligations

- Determine uses/access to network
- Develop RFPs
- Promote competition in the equipment market
- Receive payment for use of FirstNet's spectrum/infrastructure
- Consult with States on State & Local Planning
- Leverage existing commercial or other infrastructure (e.g, ARMER)
- Develop/sponsor national standards and requirements
- Represent Public Safety before standards bodies

Source: Alcatel-Lucent, "FirstNet: Implementation Timeline & Requirements", March 2012

# Timeline




Source: Alcatel-Lucent, “FirstNet: Implementation Timeline & Requirements”, March 2012

## What is "Opt-Out"?

- State opts to do its own RAN build-out
- The state's network is still part of the national network
- The state still pays access fees to FirstNet spectrum
- The state may be required to still pay fees for national core infrastructure, or may be barred from buying its own core with Federal funds
- The state <u>is not</u> excluded from national funding if it opts out
- Opt-out plans subject to regulatory approval and must demonstrate a compelling economic case
- Opting out means states can pursue novel/innovative partnerships

# Next Steps

# Next Steps

## Further Assess Regional and Local Requirements

- What are the impacts of reviewing different coverage and/or throughput figures?
- What are tribal governmental needs? Tribal gov't did not participate significantly in this study
- What are the impacts of targeting different coverage figures more specifically for each area?

# Next Steps

## Develop more detailed financial models

- What are the impacts of proposed rulemaking to force manufacturers to support all bands?
- What are the costs of subscriber equipment?
- Which sorts of phased models could the State consider or recommend for network implementation?
- Does the creation of FirstNet introduce new or different financial models?

# Next Steps

## Develop plans with private partners

- FirstNet may develop plans with national private partners, but what about locally?
- What exactly are our partner options in the new environment?
- Which partnerships are feasible? Legal? Useful?
- Is Minnesota a suitable test bed for major public/private partnerships?

# Next Steps

## Prepare for FirstNet

- The State will need to articulate its needs to FirstNet. This report is a good foundation.
- Is this a good national blueprint?
- The State should work to develop a national model that works for it—or plan accordingly if it cannot (opt out).
- FirstNet is required to leverage existing infrastructure to the fullest extent possible. The State should begin a full assessment of its infrastructure.

# Next Steps

## ACT QUICKLY

- FirstNet timelines are coming quickly!
- The state should formally incorporate broadband activities into its governance structure
- The Governor will be required to respond to FirstNet's needs and should be correctly informed of all options and implications

# Questions?

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