Technological Advisory Council

Receivers and Spectrum Working Group

27 June 2012

Charter

The *Receivers and Spectrum* Work Group will tackle the issue of the role of receivers in ensuring efficient use of the spectrum and how to avoid potential obstacles to making spectrum available for new services.

Working Group Members

- Lynn Claudy
- Richard Currier
- Dick Green
- Mark Gorenberg
- Dale Hatfield
- Greg Lapin
- Brian Markwalter
- Geoffrey Mendenhall
- Pierre de Vries
- Bob Pavlak
- Julie Knapp
- Dennis Roberson

Case Studies

- Understanding the spectral areas where receiver issues may be pronounced and / or where there is considerable interest in re-farming or sharing spectrum, and where the spectrum is not the focus of current rule making [or rule-making or rulemaking].

Case Studies

Areas of Focus

- DTV
  - Channels 2-6, surrounding 72-76 MHz
    Evaluate optimum use of TV channels 2-6 after auctions and spectrum repacking
  - Rest of TV Channels 7-51
    Examine DTV receiver interference immunity improvements for changing RF environment (new unlicensed devices, re-packing DTV band spectrum to mobile broadband, mobile broadband in adjacent bands, introduction of mobile DTV services)
- 2.4 GHz Unlicensed / Broadband Radio Service (BRS)/ Educational Broadband Service (EBS) / Terrestrial Mobile Satellite Service (MSS)
  - 2.4 GHz receivers may need to be operable in the presence of terrestrial MSS base stations and BRS/EBS handset transmissions (2495 MHz and above)
  - Could leverage fact that most 2.4 GHz chipsets have common Tx/Rx path to improve receiver performance by mandating better transmitter OOB attenuation
  - FCC should evaluate / test samples of 2.4 GHz products to assess receiver selectivity and rejection of unwanted emissions from neighboring BRS/EBS band

Case Studies

Areas of Focus

- 3550 – 3650 MHz military radar and non-federal FSS earth stations
  - UK test results of co-channel interference from radars (above 2.7 GHz) into mobile broadband systems (2.6 GHz UMTS & WiMAX) suggests that the size of exclusion zones in US can be reduced (requires more modeling and testing), with appropriate C/I protection
  - Could use low power small cells in 3550 – 3650 MHz
- 2700 – 2900 MHz federal radars
  - UK encountered unanticipated interference from planned wireless broadband deployments in the 2500 – 2690 MHz band to radars operating in the 2700 – 2900 MHz band, requiring the addition of filters to the radars
  - NTIA / FCC investigation underway into a few cases of interference to weather radars in the 2700 – 2900 MHz from broadband radio systems in the 2496 – 2690 MHz band
  - FCC / NTIA should study causes of interference between wireless broadband and radars, and consider if receiver interference limits would be appropriate

Receiver Enhancement Areas

Problem

- What are potential approaches that might be deployed to enhance spectrum utilization through the improvement of our approach to the receiver side of wireless systems?
- Receivers today are developed without adequate knowledge of future environment performance constraints

Ideas Evaluated

- Standards Based Regulated Receiver Performance – List of Applicable Standards (potential of FCC Database)
- Best Design Practices / R&D Investments to Enhance Receivers
- Interference Limits Policy Approach
- [Status Quo]

Standards Based Regulated Receiver Performance

Progress

- Inventoried standards and regulations for RF performance of television receivers
- Initial evaluation of standards based regulatory approach

Benefits

- Direct approach to resolving receiver issues
- National Technology Transfer & Advancement Act: Federal agencies are to use technical standards developed by voluntary, consensus standards bodies (e.g., OMB Circular A-119)

Key Enablers

- Industry consensus captured in a standard, referenced by regulation, is preferable and more flexible than incorporating a similar level of detail directly in regulation
- Ensuring that all essential stakeholders are “at the table”

Actionable Recommendations

- Develop clear project definition to begin standards work. Define scope and purpose of the standard. Is the RF environment in which the receiver will operate known, both present and future?
- Organize cooperative effort of FCC, NTIA, industry groups, service providers, and equipment manufacturers
- Explore the potential for the FCC to provide a web accessible standards repository
- Continue examination of the root causes of receiver susceptibility to interference, and the role that public and private standards play in receiver performance

Best Design Practices / R&D Investments

Progress – Identified Key Issues

- Legacy receivers are expected to operate in new and changing RF environments
- Knowledge of future spectrum allocations helpful to setting receiver standards
- Primary design challenge is front-end stage, which can be overloaded by strong interference

Benefits of Best Design Practices and R&D Investments

- Improved resistance to signals from adjacent channels and adjacent services (out-of-band)
- Free up spectrum by reducing guard bands and taboo reservations
- More flexibility in assigning spectrum to adjacent services

Key Enablers

- Adaptive, low cost, low power Software Defined Receivers (SDR) with over-the-air upgrades
- Increased ability to withstand unwanted strong signals without overloading
- Improved front-end performance including dynamically tunable filters; adaptive antennas; advanced interference cancellation techniques

Actionable Recommendations

- Stimulate R&D investments into key enabling receiver technologies that allow a greater spectral density of signals
- Recommend minimum receiver performance levels by spectrum segment

Interference Limits Policy Approach

Progress

- Interference limits = interference an assignee's system should be able to tolerate; can only claim harmful interference if the limit is exceeded, and its performance degrades
- Have developed sample interference limits for TV bands, 2.4 GHz

Benefits

- FCC can manage Rx/Tx trade-off without mandated device performance standards
- Delegates optimization decisions to operators
- Provides certainty to licensees: future neighbors won't exceed known interference limits to receivers; won't be surprised by new constraints on transmitters
- Prevents low-selectivity receivers deployed next to currently-quiet band preventing future band reallocation to more intensive use

Key Enablers

- Incorporating interference limits policies into rules for new allocations

Actionable Recommendations

- Define interference limits for: unlicensed in 2.4GHz; incumbent assignments in 3550-3650; licenses in UHF incentive auction
- The concept of Interference Limits policy may be advanced by assuming a cellular infrastructure system as the de-facto near neighbor, subject to alternative agreement between the two neighbors and with appropriate guidance from the FCC

Summary, Conclusions and Next Steps

- Receiver performance and standards play a critical role in the efficient use of spectrum
- The challenges are not new (multiple FCC proceedings, workshops, etc.)
- Significant work has already been done on “interference protection criteria”, but more band/service system analysis and testing, as well as future projections are needed
- Next steps:
  - o Further assessment of bands with near-term potential for receiver performance impact
  - o Determining how to project future spectrum plans, so industry can be more prepared
  - o Process of integrating “receiver performance” factors and the interests of all relevant partners into evolving standards
  - o Analyzing impact of adjacent cellular-based interference limits
  - o Provide actionable recommendation to TAC on an effective approach for receiver standards, interference limits, and their interaction and integration
  - o Analyze the role of enforcement and incentives in the receiver standards process

Discussion

Technological Advisory Council

Multiband Devices Working Group

27 June 2012

Charter and Working Group Members

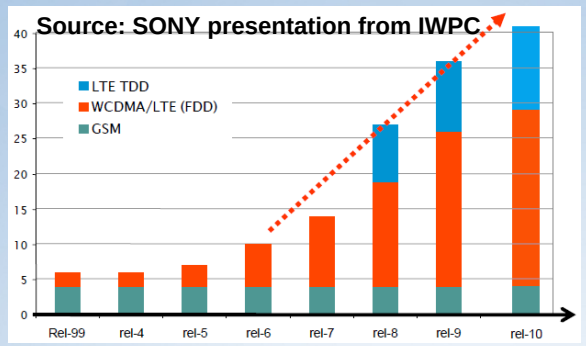
- The Multi-band Devices Working Group will study the challenges in developing subscriber equipment that is capable of operating over numerous frequency bands.

- WG Chair: Brian Markwalter
- FCC Liaisons: Michael Ha, Chris Helzer
- WG Members:
  - John Chapin
  - Lynn Claudy
  - Marty Cooper
  - Jack Nasielski
  - Mark Richer
  - Jesse Russell
  - Peter Gaal
  - William Mueller

Problem Statement

- Diverse and Complex Frequency Options
  - 22 FDD bands, 11 TDD bands defined in 3GPP R10.6, and counting
  - 4 types of positioning (GPS, Glonass, Galileo, Compass)*
  - Multiple types of WiFi, BT, NFC, etc*
- Each carrier desires different combinations of band support
- International roaming further complicates the handset design
- Future spectrum allocation continues to be fragmented
- Spectrum Aggregation being standardized in 3GPP

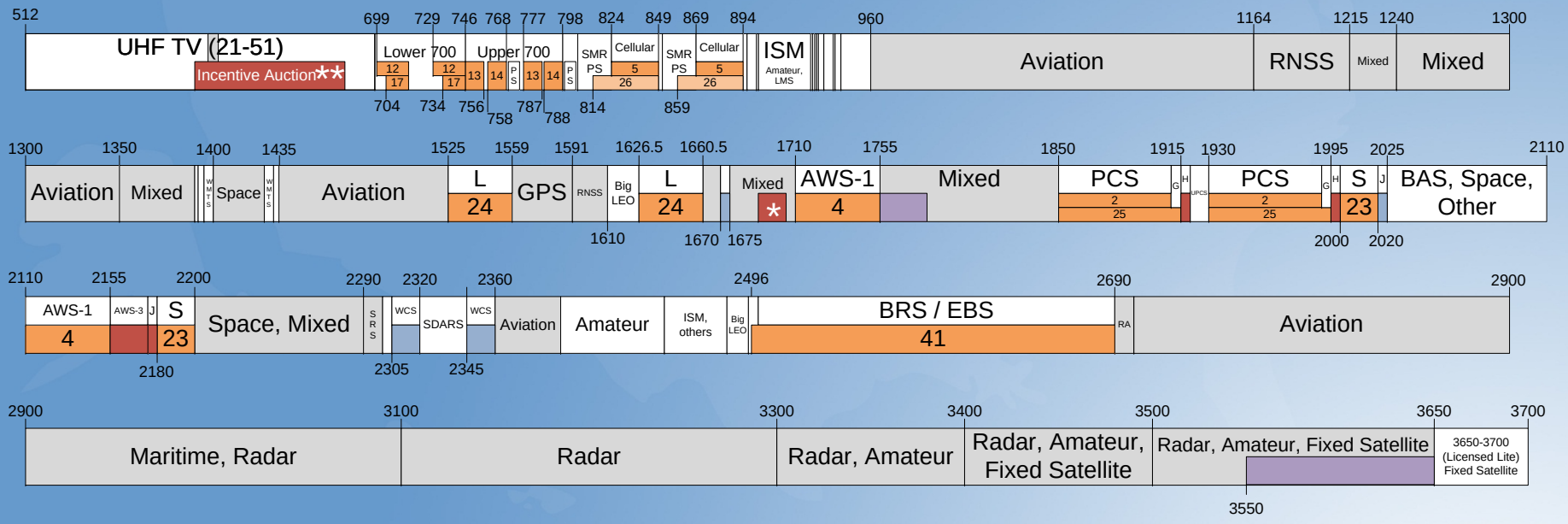
- *What is the expected roadmap for receiver improvements?*
- *How does that roadmap inform policy and industry decisions?*



Number of Bands per 3GPP Releases

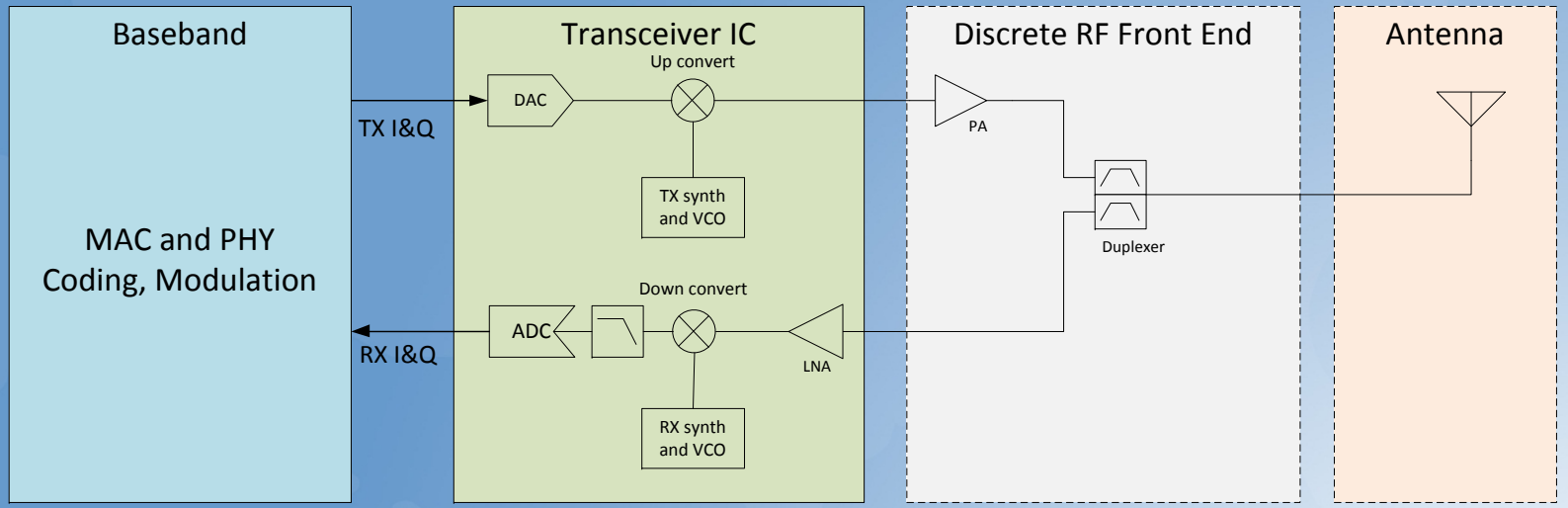
* Note that multi-mode challenges are not addressed in this report as these services offered in globally harmonized spectrum

US Current and Potential Future Flexible Use Bands



- 3GPP North American band
- 3GPP proposed North American band
- Other part 25 and 27 allocations
- Non-federal uses
- Federal uses
- Possible federal clearing or sharing
- Legislative mandate to auction
- * Legislation specifies 15 MHz between 1675 and 1710, frequencies not determined.
- ** Legislation specifies incentive auctions, specific frequencies depend on auction participation and FCC rules.

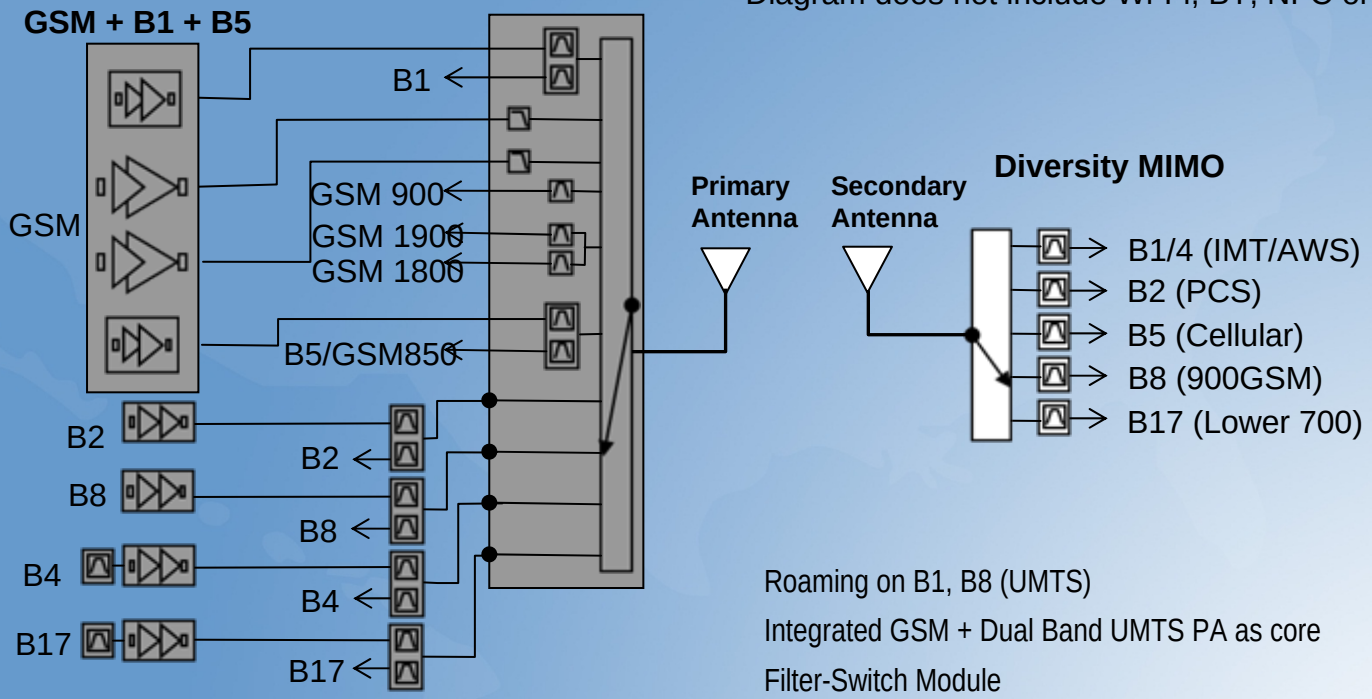
Reference Radio Architecture



- Advancements in processing power of Baseband Chipset and increased density of CMOS silicon for Transceiver IC have enabled multi-band/mode implementation in a cost-effective manner
- Due to power handling, temperature variation, and other operational requirements, Discrete RF FE and Antenna elements have become the limiting factors of multi-band radios

GSM/LTE Architecture *

* Diagram does not include Wi-Fi, BT, NFC or broadcast radios



QB GSM / EDGE

HSPA+ on B2, B5

LTE on B4 (5,10), B17 (5,10)

Roaming on B1, B8 (UMTS)

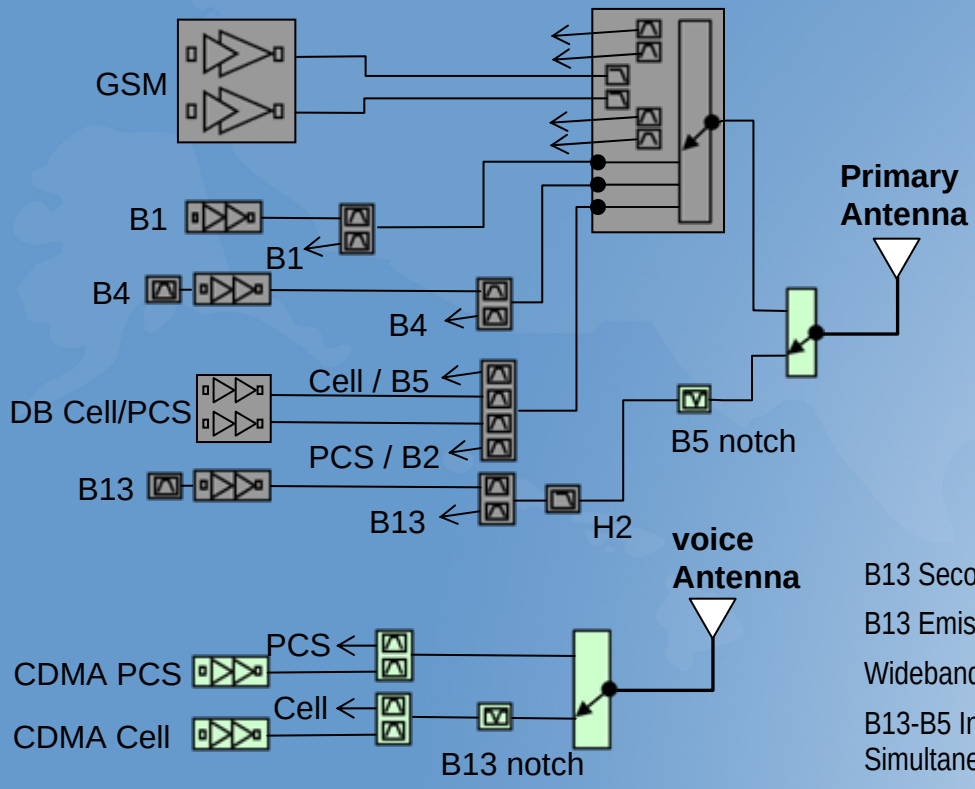
Integrated GSM + Dual Band UMTS PA as core Filter-Switch Module

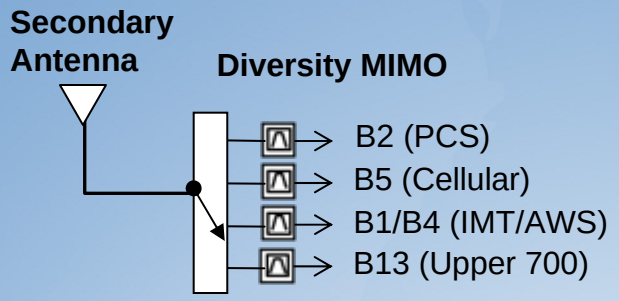
PA-duplexer chains for other bands;

Diversity on data bands

Tx filtering only on LTE bands

CDMA/GSM/LTE Architecture





EV-DO / 1xRTT on B2, B5

LTE on B13 (10), B4 (5,10)

Separate 1xRTT for simultaneous voice and data on cell, PCS

Roaming on GSM, B1 (B8 capability may also be included)

B13 Second Harmonic interaction with GPS (H2 filter)

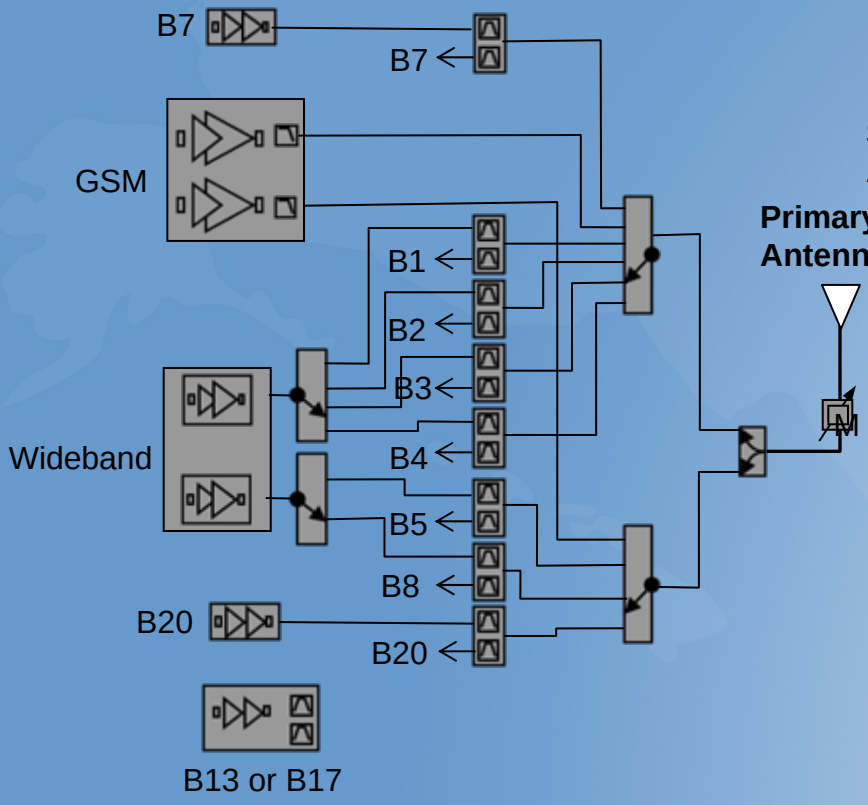
B13 Emissions into Public Safety Radio (NS_07)

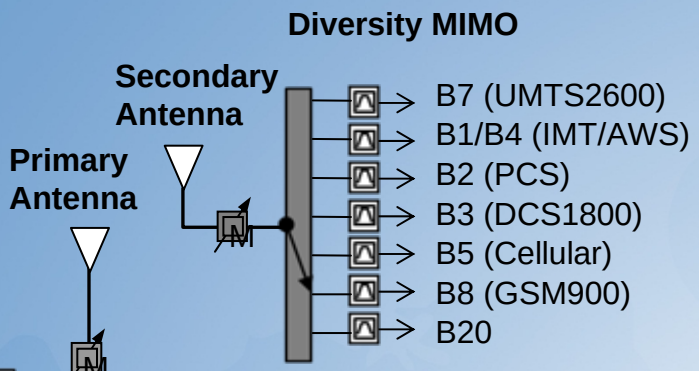
Wideband antenna 757-2170 MHz

B13-B5 Intermodulation distortion interaction necessitates notch filters for Simultaneous Voice-Data

Dual radio chains for Simultaneous Voice-Data; 3rd antenna needed

Proposed Diplexer Architecture for Carrier Aggregation





Transmit Rx/ Diversity-MIMO split between antennas

Diplexer separates high and low bands on primary

Wideband PA for core bands (low: 800-1000, high 1700-2000)

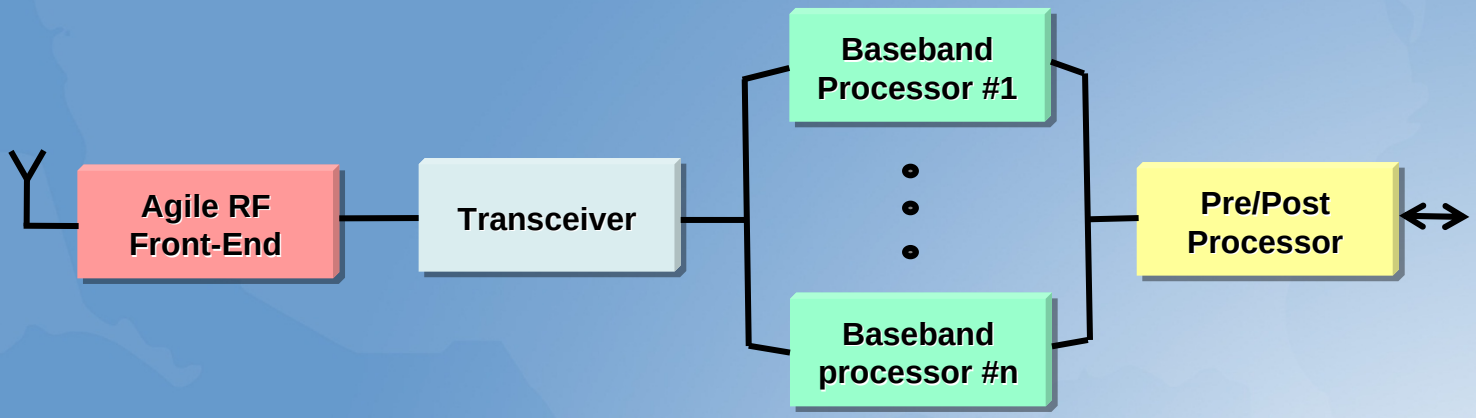
PADs or SB PAs for satellites

GSM Rx co-banded

Secondary antenna typically smaller, poorer performance

Possibly antenna tuning or adaptable antenna

Future Multi-Band Radio Architecture



- Agile RF front-end band selection process: dynamic RF band selection
- Transceiver processes selected band : RF wide-band processing
- Programmable baseband processing: concurrent baseband channels processing
- Channel data aggregation: pre/post processing to align and aggregate data from different channels for enhanced throughput to/from the handset
- Transition from present to future architecture will occur incrementally as component performance evolves and digital processing continues to embrace more of the subscriber unit

Breakout of Future Investigation

- Antenna
  - Wideband
  - Multi-tap
  - Tunable
- Tunable Elements
  - Variable capacitors (MEMS, switch banks, BST, etc)
  - Selectable elements (filter / duplexer banks)
- Analog/Digital Converter (w/ PA)
- Processors

- Others
  - Switches (MEMs, ohmic MEMs, improved semiconductor: higher isolation, lower loss, more throws)
  - Linearizers (Digital PreDistortion, ET as linearizer, etc)
  - Transmit MIMO / Spectrum Aggregation
- Multi-mode Support
- What are the key challenges of agile multi-band radio?

Future Policy Considerations

- Policies that consider receiver performance and operation in a dynamic RF environment are appropriate for maximizing spectrum efficiency

- Technology time frames and policy relationship
  - 1 to 3 years – technology available today, short term proceedings such as AWS-4
  - 3 to 5 years – technology visible today, proceedings such as statutory auction deadlines
  - 5 or more years – predicted technology, long term policies should align with roadmap

- Policies on research and accelerated development of software defined radio and downloadable applications should be encouraged

Technology Advisory Council
PSTN Transition

Meeting

June 27th, 2012

PSTN Transition - Group A

(The “A Team”)

- Daniel Kirschner (FCC)
- Henning Schulzrinne (FCC)
- Nomi Bergman (Brighthouse)
- Russ Gyurek (Cisco)
- Anthony Melone (Verizon)
- Charlie Vogt (Genband)
- Joe Wetzel (Earthlink)
- Marvin Sirbu (CMU)
- Jack Waters (Level 3)
- Harold Teets (TW Telecom)
- John McHugh (OPASTCO)

With contributions from other technical experts

PSTN A vs B Work Group Simplification (June)

Initial Group Assignments
PSTN A
Copper Retirement
PSTN Users
Interconnection
Database Transition

June Group Assignments
PSTN A
Copper (Retirement) Reuse
PSTN Users
Interconnection
Database Transition

Consolidated overlapping assignments into single Work Groups

PSTN B
Interconnection
Numbering
Database Transition
QoS
Robustness and Public Safety

PSTN B
Interconnection
User/Service/App Identifiers
Database Transition
QoS
Robustness and Public Safety

Questions for Group A

- Copper Retirement:
  - *What services remain dependent upon the existing twisted-pair copper plant? What services may no longer be available if twisted pair copper is no longer offered from customer premises to the wire center? What non-voice services and features will not work without modification in an all IP-based network?*
  - *What substitutes exist for services that may not be able to transition from the analog circuit-switched network? What is the cost or technological impact of the substitute?*
  - *As landline voice service decreases, what fraction of copper loops is left idle, rather than serving as DSL loops or being put to other use? How is non-voice demand for copper loops expected to change over 5-10 years?*
  - *Are there practical uses of abandoned copper and if so, what are the uses, and what are the costs (or cost drivers) and technological impediments to putting such copper to use?*

- Copper Retirement- *Answers/Recommendations*:
  - More Appropriate: Copper "replacement or transition"; retirement is premature. (*Topic was addressed in TAC 2011*)
    - Many services require copper: Alarm/security circuits, elevator phones, ringdown circuits, etc. Transition will take place over time
    - Technology advances push capability of Copper (VDSL2 vectoring, bonding technologies, advances in EoC, etc)
    - *Note: NOT all Copper is equal. Providing >10mbps requires investment and upgrades*
  - Our working group sees a productive, current role for copper infrastructure. Longevity will be determined via the cost/benefit comparison based on bandwidth needs (service requirements)

Questions for Group A

- Interconnection:
  - *What methods have evolved for the exchange of traffic in the hybrid IP-based/circuit-switched network? How will those methods transition as the network shifts to being wholly IP-based?*
  - *How might interconnection requirements and provisioning evolve as consumers adopt new communications technologies, such as HD voice or video?*
  - *Do technological interconnection issues exist at higher protocol levels, e.g., SIP?*
  - *What architectures might evolve to support VoIP interconnection and interconnection of advanced communications services? How would architectures function at different network layers (e.g., MPLS, IP, SIP)?*
  - *Develop a detailed matrix of technical issues that need to be worked out for an IP interconnection framework, the entities who would need to be involved in each aspect, and preliminary thoughts on possible technical solutions.*

- Interconnection: Not a single (simple) solution
- IP-to-IP interconnect for ***Data*** and ***Internet*** has been happening for 20+ years
- IP-to-IP Interconnect for ***Voice (apps)*** now being implemented globally at a rapid rate
  - IP Interconnect, VoIP Peering, IPX, etc - Multiple Standards Bodies engaged
    - ITU-T, ATIS-PTSC, I3, GSMA, FCC, CRTC, CableLabs, 3GPP
  - Implementation outpacing regulation
- IP Interconnect for VoIP will be transformational as it will eliminate need for legacy, post-divestiture structures such as LATAs, Rate Centers, Routing rules, etc.
- Parallel FCC initiatives
  - FCC Rulemaking on IP-to-IP Interconnect (USF/ICC Report and Order and FNPRM)
  - TAC Working Groups Assigned and will make recommendations
- Other market forces and considerations
  - Interconnection type (Public vs Private) needs to be evaluated for the needs of Voice and Apps
  - Modernization (aging equipment, automation, new technical options, etc.)
  - New interconnect biz opportunities: Video, Messaging, UC in general plus VoLTE
  - Potential implications to intercarrier compensation

PSTN Interconnection	VoIP Interconnection*
• Rules in Place	• Clarification needed with respect to voice traffic rules
• POI Rules in Place	• POI arbitrary
• Interoperability standards	• Interoperability concerns
• Compensation Defined	• Contractual arrangements
• Traffic exchanged is voice	• *Apps can be voice, data, video, SMS, MMS
• Dedicated direct connection	• Could be direct or indirect interconnection

IP Interconnection is transformative and has cross dependencies and impacts on Databases, QoS, PSTN User features, Regulation, Intercarrier compensation, etc

Interconnection: Read-out

- PSTN Working Groups A and B have consolidated the interconnection work into Group A
- Preliminary analysis has been worked with the sub-group
  - Reviewed questions from both working teams and developed preliminary answers
  - Developed interconnection scenarios with diagrams to scope the impacts
  - Consulted with experts to advise on industry standardization work
    - ITU, ETSI, GSMA, CableLabs, ATIS, i3 Forum, SIPConnect, etc
  - Drafted the Matrix of Considerations for implementing VoIP* Interconnection
  - Distributed synopsis of Further Notice on IP-to-IP Interconnection
- Next Steps:
  - Explore additional apps (video conferencing, OTT etc.) for additional QoS requirements
  - Seek additional industry review to validate and identify additional considerations
  - Finalize Matrix of Considerations, what are M2M impact/requirements
  - Provide Final Answers to Work group questions.

Questions for Group A

- Database:
  - *What legacy databases will need to transition to a future all-IP environment?*
  - *How will databases that are essential to the operations of the PSTN need to evolve to operate in an IP-based network?*

Group A Database Focus

- Overview of all relevant PSTN related DB's (see appendix)
- Transition/Post PSTN needs: compatibility, interoperability requirements
- Market drivers
- Top 4: LNP, DNS, ENUM (E.164), Geo-location

Database Discussion – Group A

- Traditional PSTN databases previously deployed may lose their relevance as we move forward to IP-based communications
- Database information may no longer be solely based on geographical constructs or numbers
- Multiple private databases (e.g. ENUM, MAC addresses) may need to report up to a master-type “Mediation” database to ensure “any-to-any” reach-ability regardless of network, location, or end device used
    - Similar functionality exists with DNS in the Internet
- Concerns over security / confidentiality of information populated within these databases – (e.g. who has access to the info, anonymity issues, how is 9-1-1 affected)
- Database discussion linked to numbering plan working group (Group B)

Summary

- Copper will continue to play a role during and after the transition.
  - Issue: All copper is not equal in terms of BW capability
- Interconnection:
  - Many options and methodologies from tech standpoint
  - What “needs” be connected in future (beyond voice)
  - Application interconnection is the right focus
- Database
  - Many PSTN databases in Existence
  - Team will focus on identifying needs to interoperate, and backwards compatibility needs, which databases will play role post-PSTN
- The group has begun some discussions about the future of broadband access technology including the ability going forward to support competition
- Looking forward to advice from FCC and fellow TAC members on all issues

Technological Advisory Council

Wireless Apps and Services (M2M) Workgroup
Friction Point Analysis

TAC Wireless Apps and Services (M2M) Working Group

Name	Company
Shahid Ahmed	Accenture (Workgroup Chair)
Kevin Sparks	Alcatel-Lucent
Bud Tribble	Apple
Tom Evslin	Evslin Consulting
Peter Bloom	General Atlantic
Milo Mendin	Google
Robert Zitter	HBO
Deven Parekh	Insight Venture Partners
Glen Tindal	Juniper
Dave Tennenhouse	New Venture Partners
Wesley Clark	Wesley K. Clark and Associates
Greg Chang	Yume
Walter Johnston	FCC Laison

M2M Working Group Mission Statement

The TAC Machine to Machine (M2M) Working Group's mission is to accelerate the growth of the M2M market through education, policy development, and the reduction of barriers to entry for new entrants.

Objectives:

1. Identify legacy regulation that impedes growth in the new M2M paradigm
2. Provide guidance and recommendations for industry groups on standardization, privacy and security
3. Identify economic enablers that will act as catalysts for growth and job creation
4. Identify specific industry vertical issues and challenges
5. Identify metrics to gauge how the M2M market and traffic is growing and the impact it will have on wireless networks
6. Recommend actions to the FCC Technological Advisory Council
7. Facilitate the conversation with the M2M industry and community

Friction Point Analysis Objectives

1. Derive common definition of M2M
2. Identify top verticals (near and future term)
3. Identify key challenges/inhibitors of M2M growth
4. Identify catalysts to encourage M2M growth
5. Provide set of recommendations

Our Approach

Initiated survey of stakeholders in relevant sectors and targeted ~30 companies. To date the M2M TAC group has interviewed over a dozen companies and surveyed key issues impacting vertical opportunities: Regulator, Technical, Certification, Standards, Cost, and Others.

Create Interview Target List and Questions → Conduct Company Interviews → Consolidate and Summarize Findings → Developed Final Recommendations

Participants

Company	Description	Vertical
Sprint	Network Operator	Multiple
verizon	Network Operator	Multiple
KORE	MVNO	Multiple
QUALCOMM	Devices and Platforms	Multiple
nest	Solution Provider	Home Automation
OnStar	Solution Provider	Telematics
EATON	Devices	Energy
SOUTHERN COMPANY	Utility	Energy
TELCARE	Solution Provider	Healthcare
Sempra Energy	Utility	Energy
ERICSSON	HW and Platforms	Multiple
Google	Solution Provider	Multiple
at&t	Network Operator	Multiple

Questions Asked

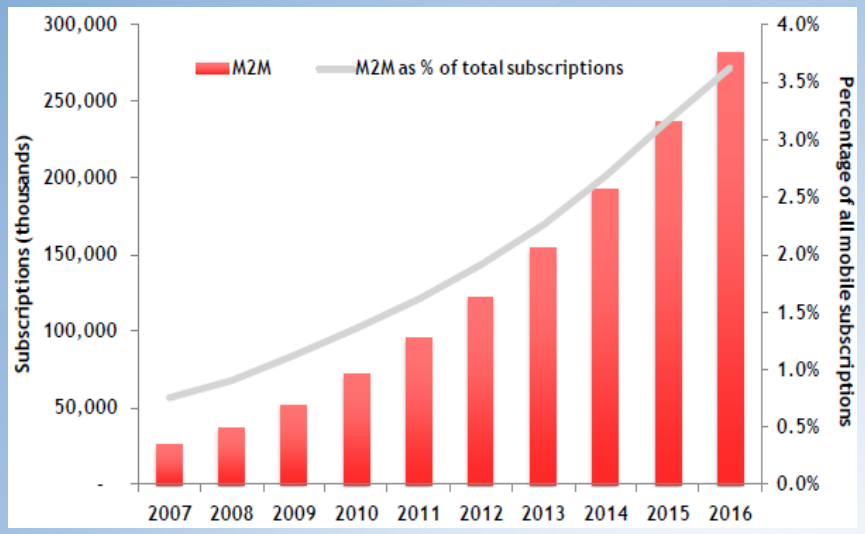
1. How do you define M2M?
2. What do you believe are the key verticals?
3. What are some inhibitors to M2M growth?
    a. Regulatory (i.e. legacy regulations that inhibit M2M)
    b. Standards
    c. Technical
    d. Security
    e. Certification
    f. Other
4. What do you think the FCC should do that could help remove some of these inhibitors or create a catalyst for M2M growth?

M2M Characteristics and Definition

- M2M revenues estimated to be $1.2 T by 2020
- Broad range of applications and vertical sectors:
  - Sector Specific Challenges
  - Dominated by 2G
  - Common platform “one size fits all solutions” not likely
  - Challenging cost, technical and service issues
  - Extensive use of devices in both licensed and unlicensed spectrum
  - Wide variances in requirements of bandwidth, data consumption and Quality of Service

Source: OECD 2012

M2M is Starting to Gain Traction with subscriptions Increasing by 4x between 2010 and 2016



Source: Pyramid and Accenture Research

Multiple Definitions Exist

- ***OECD Definition:***
  - **Devices actively communicating using wired and wireless networks, are not computers in the traditional sense and are using the internet in some form or another.**

- *Connected Definition:*
  - A purposeful device connecting back to another device or server through a dedicated often restricted wired or wireless connection.
  - The device must take the information and do something useful with the data to make intelligent decisions.
  - Any device to device wireless connectivity beyond a mobile phone, computers, tablets, and handhelds that require user intervention are not counted.
  - Measured by the number of lines or data plans.

- *Use Case Definition:*
  - Different applications across vertical markets with common layers and building blocks: Device Hardware, Wired or Wireless Modem, Network, Middleware, and Application.
  - Customized by vertical applications, an automobile differs from a medical device.
  - Divided into devices that are consumer centric services such as eReaders, Business to Business and Business to Consumer services such as healthcare.
  - M2M is mobilizing mobile data collection and management.

Initial Observations – *Challenges and Inhibitors*

Regulatory

- M2M margins very tight and rate/billing plans need to take this into consideration
- Regulations and certifications vary by country (e.g. how long can I store patient data - HIPA?)
- Requirements differ between use cases, is eCall required on every voice capable device?

Standards

- Proprietary protocols stymie innovation and growth where open architecture should be used
- Depending on the vertical, standard bodies creates multiple competing standards without interoperability
- Some applications can drive standardization process, others more dependent on development of standards to scale

Technology

- Uncertainty of technology roadmaps and pricing (2G legacy, 4G or future disruptive technology)
- Commercial networks are not secure
- Proprietary solutions needed for low latency (~10 milliseconds) critical solutions
- Expected billions of devices increases demand for IP addresses and IPv6
- Lack of pervasive connectivity requires investing in network infrastructure (Wi-Fi)
- Cost and time spent of developing new wireless modules for embedded devices
- Lack of engineers and companies that understand wireless, radios, and antennas.

Certification

- Serial certification by multiple federal agencies required for some sectors (e.g. health and FCC)
- Rigid HW certifications but there is a lack of testing for applications
- Lack of guidelines on certification

Other

- Lack of coverage in rural areas
- Many businesses do not value cost savings with longer payback periods
- Data ownership issues as machines interconnect. Who owns data: end user, each connecting entity? How are data rights granted?

Initial Observations – *Catalysts for Growth*

Regulatory

- Keep new regulations at a minimum
- Remove Friction, and open regulation to recommendations from Industry/Public

Standards

- There is a need for standards around ***applications*** platforms not just hardware
- Create a database or forum to open communication between global standards bodies

Technology

- Provide access to technology roadmaps
- Quality of Service for Mission Critical applications/SLAs
- Commitment to long term service support

Certification

- Create a “Network Safe” Certification
- Guidance for companies to build devices so that they pass certification the first time
- Common certification process across multiple carriers

Education

- Funding and encouragement for engineering and science education to increase America’s competitiveness with other regions in the world
- Education of the public about benefits of M2M technology to drive adoption

Other

- Address spectrum refarming and 2G sunsetting with one national 2G network
- M2M driven by compliance and cost savings
- Deliver simplicity and trust
- Allow for more flexible billing strategies

Initial Considerations

1. Create a Certification Lite “Safe Network” to enable lower cost solutions (devices and applications)
2. Work as an industry to show technology roadmaps (e.g. when is 2G being sunset?) and price-points to guide application vendors
3. Provide a guidance on what defines “well behaved” applications
4. Provide exceptions for access to spectrum for critical infrastructure providers
5. For 2G sunset, consolidate into one network – M2M Network?
6. Investigate feasibility of Spectrum set aside. Look at leveraging TV White Space
7. FCC should work with peers around the world to enable globalization
8. M2M should not be included as part of Universal Service Fund tax structure (FNPRM)
9. Consider seeding certain vertical market to spur growth e.g. mHeatlh

Next Steps

1. Identify near term actions FCC/industry can undertake to grow M2M market

2. Develop education material describing opportunities and issues

3. Target potential policy issues requiring attention to accelerate market

4. Develop workshop focused on convergence of sector/carrier/agency issues

PSTN B Successor Networks Working Group

Co-Chairs:

Brian Daly, AT&T

Tom Evslin, Evslin Consulting

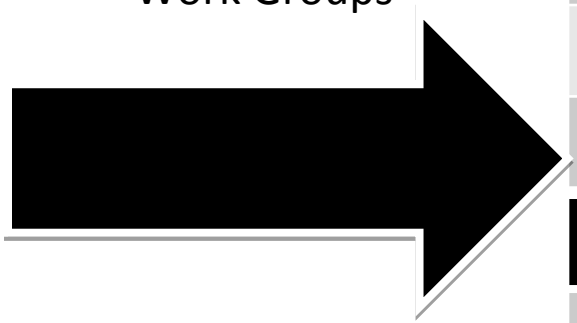
PSTN Successor Infrastructure Work Group

- The PSTN Successor Infrastructure Work Group will focus on identifying key elements essential to an IP-based real-time communications infrastructure. As consumers and businesses turn to other networks to replace functionality previously provided by the current voice network, questions arise as to how those networks can replicate the best characteristics of the circuit-switched network while taking advantage of their advanced technological underpinnings. Successor networks face new quality-of-service and robustness challenges. They may depend upon new databases and take advantage of new interconnection standards. The work group will look past the challenges of transitioning from the legacy circuit-switched network, and focus on the technical characteristics and user experience of successor networks. The work group will make recommendations to the Commission to identify challenges to the effective performance of successor networks.

PSTN A & B Work Group Simplification

Initial Group Assignments
PSTN A
Copper Retirement
PSTN Users
Interconnection
Database Transition
PSTN B
Interconnection
Numbering
Database Transition
QoS
Robustness and Public Safety

Consolidated overlapping assignments into single Work Groups



June Group Assignments
PSTN A
Copper Retirement
PSTN Users
Interconnection
Database Transition
PSTN B
Interconnection
User/Service/App Identifiers
Database Transition
QoS
Robustness and Public Safety

Work Group Progress

- Held 4 conference calls:
  - Discussion on the questions tasked to the working group
  - Sub-team assignments were made
- Worked with PSTN A leaders to clarify and combine overlapping tasks
- Received input from ATIS on their focus group work on PSTN Transition
- Breakout sessions to address specific sub team focus areas

Identifiers for Users/Services/Applications

- **Champion**: Mark Bayliss
  - **Participants**: Kevin Kahn, KC Claffy, Mark Bayliss, John McHugh, Jesse Russell, Charlotte Field

- What changes might be expected in a numbering plan optimized for IP-based communications services? (For example, current numbering systems are tied to physical resources, such as lines, and are often service specific, e.g., SMS short codes.)
  - What are the obstacles to assigning numbers to users, analogous to how domain names are assigned, rather than to service providers?
  - Should number assignment need to retain a geographic component? For example, do numbers still need to be assigned to specific rate centers in an all-IP world?
  - How can the receiver of a call validate that the caller is authorized to use the number or other identifier ("caller ID validation")?
  - What role is ENUM going to play as a number mapping service as the numbering system evolves? Is there a need for additional or alternate solutions?
- How might technological changes drive signaling requirements and number translation capabilities?

Identifiers - Topics of Discussion

- Numbers will be just one kind of identifying scheme
  - Moving toward a set of identifier directories that will map you to the target
  - There will exist multiple mapping databases
  - Need some schema for this multiple disparate directories to communicate with one another
- Geographic-based Numbers will continue to be a gating issue during the transition as long as there are devices that use numbers as identifiers
- As we consider the identifiers we need to consider the Linkages between numbers and PSTN databases
- NANP resources exhaust sometime after 2042 per NANPA report 4/20/2012
- Non-geographic codes assigned for services like M2M forecasted exhaust is 2032
- E.164 to SIP mapping being done today using private ENUM type databases
- Concerns over Country Code 1 (NANP serves 19 countries)

Quality of Service

- **Champion**: David Clark
  - **Participants:** Kevin Kahn, Dale Hatfield, Joe Wetzel, Jesse Russell, Dan Reed

- How will the use of end-to-end IP connectivity impact QoS? Is there a need for defined call quality metrics? How can we properly measure and assess the difference in QoS in IP service relative to circuit-switched service? What are the complexities associated with measuring IP QoS?
- What entity or entities can best perform reliable, unbiased and comprehensive QoS testing? Can this be done by industry and/or government groups or labs and if so, do such groups/labs exist already?
- Can end-to-end QoS be provided across service providers? What models seem possible (e.g., DiffServ, resource reservation, separate physical, or L2 networks)?
- How would the use of multiple media (high-quality audio, video) impact QoS considerations?

QoS – Topics of Discussion

- QoS and interconnection are inter-related and many issues impact both groups
  - Voice Interconnection between carriers, without using circuit switched PSTN, has occurred for several years and is fairly mature in certain segments, such as inter-MSO connection
- Efforts should focus on defining the basics of interconnection - the NNI
- At the same time, there are several patterns of interconnection, and a lot of issues are being sorted out bi-laterally, or within specific groups
- There would seem to be a number of questions related to payment
- Current preference among major carriers to build a private, IP-based networks to carry voice, rather than carry the voice over their public Internet offering
  - While conventional operators have generally chosen to use managed, dedicated services for voice interconnection over IP, some interconnection already takes place over existing Internet peering and transit quite successfully
  - Given the declining proportion of the total amount of IP traffic that represents voice going forward, carriers may find ways to ensure QoS with segregated interconnection facilities

QoS – Topics of Discussion

- Evaluate performance (e.g. QoS) requirements on IP-based voice, reporting of any performance statistics, and QoS discrepancies
- Since private and OTT voice service will interconnect, will the same performance (QoS) requirements apply to both sorts of services? To what extent is the performance and QoS of the public Internet a matter that should be considered as part of the transition to an IP-based telephone system?

Robustness and Public Safety

- **Champion**: Brian Daly
  - **Participants**: John Barnhill, Dale Hatfield, Mark Bayliss, Marvin Sirbu, David Tennenhouse
- How will the transition affect network robustness?
- What will robustness likely improve or degrade in the transition?
- What technologies can improve network survivability? How effective are these technologies likely to be compared to existing PSTN survivability?
- Wireless
  - Backup power at base station and handsets?
  - Capacity vs. footprint tradeoffs
- Wireline
  - Backup power for both the network and home or small business environments?
  - What, if any, additional capabilities are needed from the underlying broadband network to enable 911 or other emergency services functionality that is at least equivalent to that offered by the existing system?
- **Next steps**: Need to review the December 14th workshop material

Participant	Work Group Assignment
KC Claffy	**Participant on Identifiers**, Interconnection
David Clark	**Leader of QoS**
Brian Daly	**Co-Chair Team B, Leader of Robustness and Public Safety**
Russ Gyurek	Co-Chair Team A
David Tennenhouse	**Participant Robustness and Public Safety**
Charlie Vogt (John Barnhill)	**Participant On Robustness and Public Safety**
Joe Wetzel (Chris Murray)	**Participant in QoS**
Mark Bayliss	**Leader of Identifiers, Participant Robustness and Public Safety**
Kevin Kahn	**Participant in QoS, Participant on Identifiers**
Tom Evslin	***Co-Chair Team B***
Dan Reed	**Participant in QoS**
Jesse Russell	**Participant in QoS, Participant on Identifiers**
Harold Teets	Participant in Interconnect and Copper
Charlotte Field	**Participant on Identifiers**
Marvin Sirbu	**Participant Robustness and Public Safety**
Henning Schulzrinne	Group B FCC Liaison
Daniel Kirchner	Group A FCC Liaison
Dale Hatfield	**Participant Robustness and Public Safety**
Dick Green	*(TBD – just joined the working group)*

Technology Advisory Council

Wireless Security and Privacy Work Group

Progress Report to the TAC

Meeting June 27, 2012

Work Group Membership

- Brian Daly – AT&T
- Greg Intoccia – FCC
- Kevin Kahn – Intel
- Ali Khayrallah – Ericsson
- Ahmed Lahjouji – FCC
- Dan Reed – Microsoft
- Randy Nicklas – XO Communications
- Kevin Sparks – Alcatel-Lucent (lead)
- Paul Steinberg – Motorola Mobility

Wireless Security and Privacy WG

Goals & Scope

- **Examine** security and privacy vulnerabilities of air interfaces used by commercial networks, **assess** how they are currently being addressed, and **recommend** what role, if any, the FCC should play
  - Expand beyond air interface (in coordination with the broader TAC) as appropriate
- Includes cellular and Wi-Fi wireless networks
  - Cellular and Wi-Fi
  - Networks and devices
  - Technical and operational/usage aspects
  - End user and network impacts

Wireless Security and Privacy WG

FCC Guiding Questions (1/2)

Overall

1. What are the chief areas of concern relative to the security of commercial wireless networks, and how would you prioritize them and why? [KS]
14. What roles should the FCC and other federal agencies play in these areas? [KS]

Security

2. What are the most significant security vulnerabilities associated with cellular and Wi-Fi air interfaces, and how effectively have they been addressed? [KS, KK-Wi-Fi]
3. Recognizing that today's mobile communication devices house multiple transceivers operating on multiple bands, what are the security vulnerabilities associated with multi-band devices, and how effectively have they been addressed? [AK]
4. What are the security features of today's wireless networks? [KS, KK-Wi-Fi]
5. What are the future security features expected for wireless IP-based technologies? [KS, KK]
13. What steps should be taken to ensure that the security capabilities, including security settings, of mobile communication devices are not compromised, either by an infectious code or user error?" [AK/KK]

[question owners]

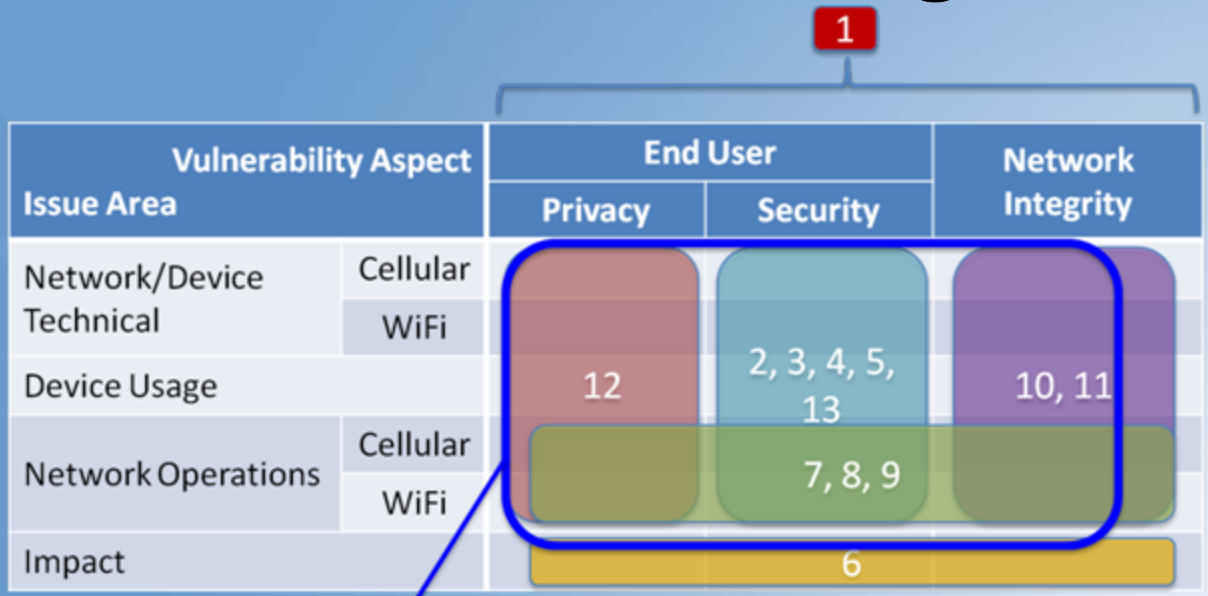
Wireless Security and Privacy WG

FCC Guiding Questions (2/2)

Impact	6. What is the scope of potential vulnerabilities? For example, could security vulnerabilities lead to service outages? Hacks of private information? [KS]
Network Operations	7. How does the industry identify breaches in security? [BD] 8. What response systems are in place for dealing immediately with security attacks? [BD] 9. Are different levels of security available to users depending upon the type of application? For example, can public safety or critical infrastructure applications be provided with greater security than an ordinary smart phone? [BD]
Network Integrity	10. To what extent is jamming a concern and what has the experience been thus far? What is and can be done about this? [PS] 11. To what extent is theft of service a concern and have there been instances where this has occurred already? What can and is being done about this? [RN,DR]
Privacy	12. What are the most significant privacy issues from a wireless technology point of view, and how should they be addressed? [PS]

Wireless Security and Privacy WG

Structure and Progress

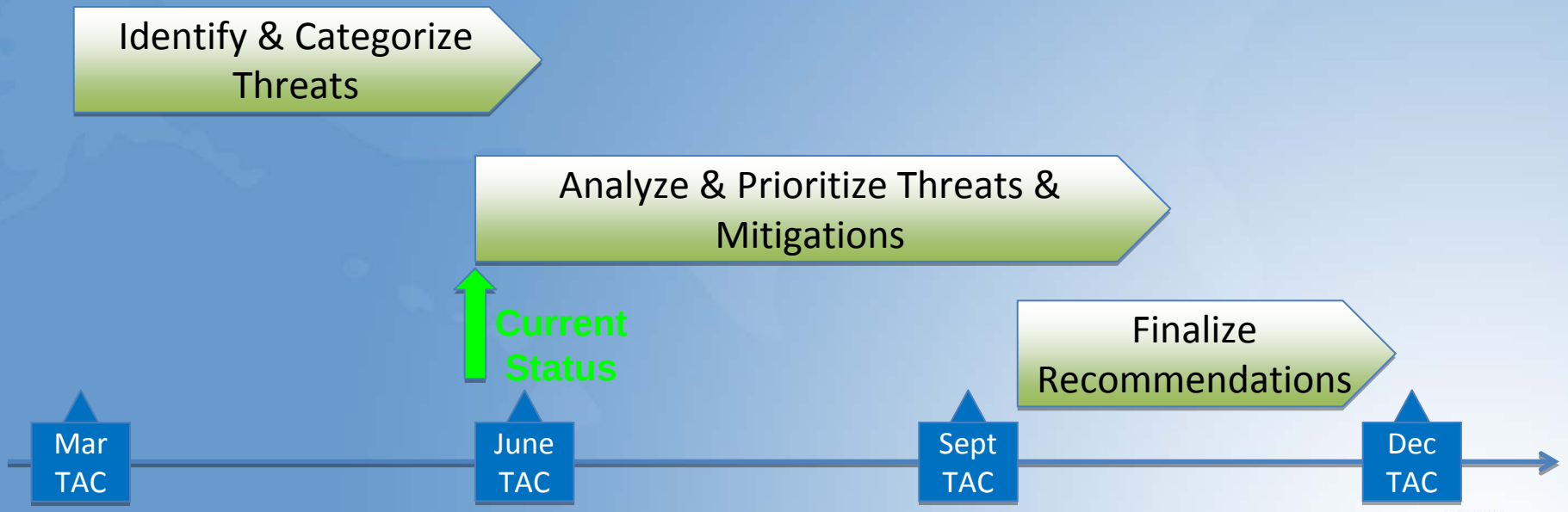


Progress: Nearing completion of scoping range of vulnerabilities and preliminary ideas for mitigation

Wireless Security and Privacy WG

Timeline

Phases



Wireless Security and Privacy WG

Key Vulnerabilities – Preliminary (1/2)

	Key Vulnerabilities	***Potential Mitigation***
Cellular	• Older generation cellular security – Weak encryption & authentication – Fake base stations – Multi-generational "bid-down" attacks • Insecure SMS used for mobile commerce or emergency messages	• Avoid or give user the option to block data usage of 2G GSM – rural areas, international roaming • Best practices guidelines on use of SMS for sensitive applications
Wi-Fi	• Open & weakly encrypted hotspots – Automated "sniffing", session hijacking • "Evil twin" masquerading hotspots – Credentials stolen via fake web pages	• Endorse and promote best practices for hotspot operators – Encryption, mutual authentication • User education on "safe Wi-Fi" – At hotspots and at home

Wireless Security and Privacy WG

Key Vulnerabilities – Preliminary (2/2)

	Key Vulnerabilities	***Potential Mitigation***
Devices/Usage	• Rich business/personal usage and data make mobiles attractive target • Open/diffuse apps environment – Malware, exposure via chain of apps – USB, SD card, Bluetooth, jail-break risks – Hacking of app data on server-side	• User security awareness education – Best practices, secure service options • Standards for trusted device execution environment – Execution, storage, user interface • Voluntary app trust certification
Network	• Denial of service attacks – Against networks, emergency services • Malware proliferation as a barrier to new services acceptance – mobile commerce, M2M	• Network & device based detection – Early detection & isolation • Secured access services

Wireless Security and Privacy WG

Next Steps

- Complete scoping vulnerabilities and mitigations in remaining topic areas
- Begin deeper-dive analysis of impact and mitigation alternatives
- Coordinate related/overlapping topics with other TAC WGs
  - e.g. M2M security aspects