

Dojack, DeNeige (IC)

From: Phillip Huang [19(1)]@barclays.com>
Sent: January-25-19 3:22 AM
To: Dojack, DeNeige (IC)
Subject: Rogers Communications Inc.: Scale for 5G deployment a growing consideration

This email was sent to: deneige.dojack@canada.ca

68(a)

68(a)

68(a)

Dojack, DeNeige (IC)

From: Calvery2, Ryan (IC)
Sent: January-24-19 9:31 AM
To: Dojack, DeNeige (IC); Smith4, Brent (IC)
Cc: Lewis, Jesse (IC)
Subject: Rogers Q4 call

21(1)(a)

21(1)(a),21(1)(b)

Dojack, DeNeige (IC)

From: Tavares, Estela Lutero (IC)
Sent: January-16-19 10:11 AM
To: Dojack, DeNeige (IC); IC.O.WIF Advisors / Conseillers PSSCLO.IC
Subject: Use of passive infrastructure making news

Published | Publi : 2019-01-15 04:54 (EST)
Received | Re u: 2019-01-16 04:57 (EST)

The Wire Report

Utilities, cities clash with telecoms over infrastructure jurisdiction

Kyle Duggan

January 15, 2019 7:35 pm EST

Electrical utilities and municipalities have arched their backs over various proposals to streamline or adjust regulatory jurisdiction when it comes to resolving disputes over use of “passive infrastructure” in Canada.

Those requests come as carriers look to not just deploy broadband network infrastructure but also thousands of 5G small cell sites and other new technology across the country.

Some telecom companies said in their submissions to a major review of Canada’s communications laws they want to expand the CRTC’s jurisdiction so it becomes the final arbitrator on certain infrastructure disputes — echoing similar proposals pitched during the fall pre-budget consultations that came amid frustrations over disparate pole attachment rates set by provincial energy regulators.

Francis Bradley, chief operating officer at the Canadian Electricity Association, says his organization is “unequivocally opposed to the CRTC getting authority over utility infrastructure.”

“We don’t think as a regulator they have either the legal authority, constitutional authority or the expertise,” he told The Wire Report in a phone interview. “We have provincial regulators that have developed and have the expertise to be able to provide opinions with respect to the safety and security of these infrastructures.”

Stakeholder responses to the Liberal government’s Broadcasting and Telecommunications Legislative Review panel’s examination of Canada’s communications laws were due Friday. The panel’s terms of reference said telecom companies will require a “legislative framework” that ensures adequate access to “passive infrastructure” — pointing to hydro poles, ducts and rights-of-way as examples — so companies can “efficiently roll out new infrastructure” to build-out their next generation and future networks.

That elicited a bevy of jockeying responses.

For example, **Rogers Communications Inc.** suggested to the panel the CRTC should be granted the ability to decide terms of access to “passive support structures of municipalities and electrical

utilities” through changes to the Telecommunications Act, and should be implemented even before the panel issues its final report, due by January 2020.

Quebecor Inc.’s submission asks, in French, for a legislative change to “confirm” the CRTC can decide disputes over the rates mobile network operators pay to municipalities for installing 5G equipment on ‘street furniture’ (fixtures like bus shelters, signs and traffic lights) and ensure that costs are “reasonable.” Others, including **BCE Inc.**, are not making their submissions publicly available yet.

The CRTC itself asked the government to vest one regulatory body with the power to be the ultimate decider on disputes over access to “passive infrastructure,” expressing concerns in its submission that various overlapping jurisdictions and competing private interests could hinder future network deployment — concerns it had also raised to Parliament this fall.

But Bradley and his organization’s panel submission argued the proposals to streamline infrastructure jurisdiction could lead to another layer of regulatory burden for them, adding he has yet to see evidence of new systemic barriers to telecom deployment.

“We seem to have a proposal here that’s a solution looking for a problem,” Bradley said.

His organization doesn’t even support using the term “passive infrastructure” for “dynamic” electrical assets like hydro poles, he said.

It’s not just electrical utilities furrowing their brows.

The Federation of Canadian Municipalities said in its submission, obtained by The Wire Report, it prefers the status quo for infrastructure governance and it’s “unclear” how Canada would benefit from jurisdictional changes to federal bodies such as **Innovation, Science and Economic Development Canada (ISED)** and the CRTC.

“At a time when resources should be spent on deployment and increasing connectivity, a change in jurisdiction would create a significant and regrettable distraction,” it said. “A change of this magnitude and nature would inevitably create system-wide uncertainty. Uncertainty inevitably generates costs as each stakeholder’s roles, obligations, authority, etc., are ironed-out.”

A joint-submission by the **SouthWestern Integrated Fibre Technology Inc. (SWIFT)** project and the Regional and Rural Broadband project at University of Guelph recently made public was somewhat harsher.

“A centralized model where the federal regulator dictates terms and prices of passive infrastructure assets would be economically inefficient due to variation in costs and conditions at the local level across Canada’s diverse communities and regions,” it said. “Such a regulatory strategy would also run against the grain of Canada’s unique federalist constitutional arrangements and may lead to complex and intractable litigation.”

That submission also argues the way “passive infrastructure” was brought up in the panel review’s terms of reference “replicates standard talking-points of carriers” who want to minimize consultations with local authorities and pay more reasonable rates for “accessing publicly-funded passive infrastructure.”

It notes the numerous small cell transmitters required for next generation networks are “likely to raise concerns by residents and businesses in the vicinity whose property value may be perceived to be impacted by these antenna deployments.”

A report from Accenture Inc. last year estimated there could be as many as 273,000 small cells deployed across Canada over the next five to seven years, and that companies will need to invest some \$26 billion in 5G network infrastructure.

The broadcast and telecom review panel received some 2,000 written submissions by various parties, which will be posted online by June 30, the deadline for its consultation summary report, according to the panel’s spokesperson Stéfanie Power.

“The Panel wants to take time to read, review, and digest the submissions, and has indicated that the submissions will be made public when it releases the What We’ve Heard Report. Interested parties are welcome to make their submissions public and many have already done so,” Power said by email.

Some have chided the panel for the publishing delay because it could take months before all the written submissions are made public.

University of Ottawa law professor Michael Geist wrote on his blog he has filed an Access to Information request for the submissions and called it a “bad look” for a panel that “already conducts most of its activities in secret.”

— *With reporting by Kyle Duggan at kduggan@thewirereport.ca and editing by Anja Karadeglija at akarad@thewirereport.ca*

Dojack, DeNeige (IC)

From: Dojack, DeNeige (IC)
Sent: November-08-18 10:14 AM
To: Dei, Joel (IC)
Subject: Re: [redacted] 20(1)(b)

Okay. Thanks

From: Dei, Joel (IC)
Sent: Thursday, November 8, 2018 10:08 AM
To: Dojack, DeNeige (IC)
Subject: RE: [redacted] 20(1)(b)

No – it's all good. Sharing only for awareness.

Joel

From: Dojack, DeNeige (IC)
Sent: November 8, 2018 10:08 AM
To: Dei, Joel (IC) <joel.dei@canada.ca>
Subject: Re: [redacted] 20(1)(b)

Should I come in for that? I assume I don't need to be there for a min/DM. I'm [redacted] 21(1)(b) so I need a but of notice to get downtown

Sorry I missed the meeting yesterday.

From: Dei, Joel (IC)
Sent: Wednesday, November 7, 2018 8:10 PM
To: Dojack, DeNeige (IC)
Subject: Re: [redacted] 20(1)(b)

Hi DeNeige,

Unfortunately, I didn't see the side bar that you and Lisa had on this. The meeting referred to below happened yesterday morning. In the future I'll ensure to have invites as such sent your way.

Theres a Min/DM tomorrow on 3500. Adam Scott's team has the lead on the products. Though, Lisa has been quite engaged on them.

I'll flip the products to you now as an FYI.

Joel

Sent from my Bell Samsung device over Canada's largest network.

----- Original message -----

From: "Dojack, DeNeige (IC)" <deneige.dojack@canada.ca>
Date: 2018-11-07 7:36 PM (GMT-05:00)
To: "Dei, Joel (IC)" <joel.dei@canada.ca>
Subject: Fw: [redacted] 20(1)(b)

Did this happen and I missed it? I didn't get an invite.

From: Setlakwe, Lisa (IC) <lisa.setlakwe@canada.ca>
Sent: Tuesday, November 6, 2018 9:11 AM
To: Dojack, DeNeige (IC)
Subject: Re: [redacted] 20(1)(b)

I think so yes pls sorry

----- Original message -----

From: "Dojack, DeNeige (IC)" <deneige.dojack@canada.ca>
Date: 2018-11-05 10:15 PM (GMT-05:00)
To: "Setlakwe, Lisa (IC)" <lisa.setlakwe@canada.ca>
Subject: Re: [redacted] 20(1)(b)

----- Original message -----

From: "Dojack, DeNeige (IC)" <deneige.dojack@canada.ca>
Date: 2018-11-05 10:15 PM (GMT-05:00)
To: "Setlakwe, Lisa (IC)" <lisa.setlakwe@canada.ca>
Subject: Re: [redacted] 20(1)(b)

Do you want me to come in for this?

From: Setlakwe, Lisa (IC)
Sent: Monday, November 5, 2018 10:15 PM
To: Scott, Adam (IC); Willis3, David (IC)
Cc: Dojack, DeNeige (IC); Dei, Joel (IC); Roy, Nathalie (IC)
Subject: Re: [redacted] 20(1)(b)

Oh I'm sure it is;) we'll just need to walk them thru this

----- Original message -----

From: "Scott, Adam (IC)" <adam.scott@canada.ca>
Date: 2018-11-05 8:57 PM (GMT-05:00)
To: "Setlakwe, Lisa (IC)" <lisa.setlakwe@canada.ca>, "Willis3, David (IC)" <david.willis3@canada.ca>
Cc: "Dojack, DeNeige (IC)" <deneige.dojack@canada.ca>, "Dei, Joel (IC)" <joel.dei@canada.ca>
Subject: Re: [redacted] 20(1)(b)

Of course. We'll need our engineering branch with us, as most of the claims here fall within their purview. Am copying Dave Willis who is acting for Martin Proulx.

But on first read, [redacted] 20(1)(b).21(1)(b)
[redacted] 20(1)(b).21(1)(b)

From: Setlakwe, Lisa (IC)
Sent: Monday, November 5, 2018 6:11 PM
To: Scott, Adam (IC)
Cc: Dojack, DeNeige (IC); Dei, Joel (IC)
Subject: Fwd: [redacted] 20(1)(b)

Could we go over this tomorrow?

----- Original message -----

From: "Sachdeva, Parvinder (IC)" <parvinder.sachdeva@canada.ca>
Date: 2018-11-05 5:03 PM (GMT-05:00)
To: "Knubley, John (IC)" <john.knubley@canada.ca>, "Setlakwe, Lisa (IC)" <lisa.setlakwe@canada.ca>
Cc: "Dooher, Shelley (IC)" <shelley.dooher@canada.ca>, "Cairo, Gianluca (IC)" <gianluca.cairo@canada.ca>
Subject: [redacted] 20(1)(b)

FYI

Parvinder Sachdeva
Senior Policy Advisor
Office of the Minister
Innovation, Science and Economic Development
[redacted] 19(1)

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Heidi Bonnell [redacted] 19(1) @rci.rogers.com>
Sent: Monday, November 5, 2018 4:50 PM
To: Sachdeva, Parvinder (IC); Cairo, Gianluca (IC)
Subject: [redacted] 20(1)(b)

Parvinder / Gianluca,

[redacted] 20(1)(b)

Any questions, don't hesitate.

Heidi

Heidi Bonnell
Vice-President, Federal Government Affairs

Rogers Communications Inc.
360 Albert Street, Suite 300
Ottawa, ON K1R 7X7
[redacted] 19(1) @rci.rogers.com
o 613.667.8091 m

Dojack, DeNeige (IC)

From: Dojack, DeNeige (IC)
Sent: November-05-18 10:13 PM
To: Scott, Adam (IC)
Subject: Re: [redacted] 20(1)(b)

Just so I am clear. This analysis if from LA

From: Setlakwe, Lisa (IC)
Sent: Monday, November 5, 2018 6:11 PM
To: Scott, Adam (IC)
Cc: Dojack, DeNeige (IC); Dei, Joel (IC)
Subject: Fwd: [redacted] 20(1)(b)

Could we go over this tomorrow?

----- Original message -----

From: "Sachdeva, Parvinder (IC)" <parvinder.sachdeva@canada.ca>
Date: 2018-11-05 5:03 PM (GMT-05:00)
To: "Knubley, John (IC)" <john.knubley@canada.ca>, "Setlakwe, Lisa (IC)" <lisa.setlakwe@canada.ca>
Cc: "Dooher, Shelley (IC)" <shelley.dooher@canada.ca>, "Cairo, Gianluca (IC)" <gianluca.cairo@canada.ca>
Subject: Fw: [redacted] 20(1)(b)

FYI

Parvinder Sachdeva
Senior Policy Advisor
Office of the Minister
Innovation, Science and Economic Development

[redacted] 19(1)

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Heidi Bonnell [redacted] 19(1) @rci.rogers.com>
Sent: Monday, November 5, 2018 4:50 PM
To: Sachdeva, Parvinder (IC); Cairo, Gianluca (IC)
Subject: [redacted] 20(1)(b)

Parvinder / Gianluca,

[redacted] 20(1)(b)

Any questions, don't hesitate.

Heidi

Heidi Bonnell
Vice-President, Federal Government Affairs

Rogers Communications Inc.
360 Albert Street, Suite 300
Ottawa, ON K1R 7X7

19(1) @rci.rogers.com
o 613.667.8091 19(1)



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Dojack, DeNeige (IC)

From: Dojack, DeNeige (IC)
Sent: September-05-18 3:25 PM
To: Scott, Adam (IC); Miller, Pamela (IC)
Subject: RE: Updated text for Rogers note

Lisa's specific question was

"what is our response to their argument? Did we look into it?"

So I think we need the last sentence that explains we have looked at that part of the band. Your wording below works for me.

From: Scott, Adam (IC)
Sent: September-05-18 3:18 PM
To: Dojack, DeNeige (IC); Miller, Pamela (IC)
Subject: RE: Updated text for Rogers note

Thanks DeNeige.

Do we need the last sentence of the first paragraph? I know we've used similar language before, but now I'm wondering if it looks like we agree with Rogers that it's a good idea but we haven't moved fast enough, which isn't really the case.

21(1)(a),21(1)(b)

From: Dojack, DeNeige (IC)
Sent: September-05-18 3:02 PM
To: Scott, Adam (IC); Miller, Pamela (IC)
Subject: Updated text for Rogers note

Adam,

As discussed Lisa had two comments about the 3500 text. Are you okay with the below?

Inukshuk, a joint Bell/Rogers venture, holds 21(1)(a),21(1)(b) of the 3500 MHz spectrum, primarily in urban markets. Xplornet holds 21(1)(a),21(1)(b) and some smaller rural wireless Internet service providers also have licences. In the 3500 MHz consultation launched in June 2018, Innovation, Science and Economic Development Canada (ISED) proposed options for taking back a portion of the licences in order to auction them for 5G use 21(1)(a),21(1)(b)

21(1)(a),21(1)(b) 21(1)(a),21(1)(b)

21(1)(a),21(1)(b)

21(1)(a),21(1)(b) 21(1)(a),21(1)(b)

21(1)(a),21(1)(b)

21(1)(a),21(1)(b)

21(1)(a).21(1)(b)

21(1)(a).21(1)(b)

21(1)(b).23

21(1)(b).23

SEP 06 2018

Security classification: Confidential	
CCM Number: BN0000725	
Lead Sector: SIPS	Consulted: STS
Contact: Pamela Miller, SIPS, TIPB 343-291-2634	
Originator: DeNeige Dojack, SIPS, WIF	
Action Required: For information	

ADVICE TO THE MINISTER OF INNOVATION, SCIENCE AND ECONOMIC DEVELOPMENT

Meeting with Rogers

SUMMARY

- You will be meeting with Rogers President and Chief Executive Officer (CEO), Joe Natale.
- We understand Mr. Natale wishes to discuss the 3500 MHz consultation, the Canadian Radio-television and Telecommunications' (CRTC) high pressure sales tactics inquiry, and access to utility poles.
- Other potential issues may include: the Broadcasting and Telecommunications legislative review and the CRTC's low-cost data-only plan proceeding, the final CRTC wholesale wireless roaming rates, and the Fairplay website blocking proposal.

BACKGROUND

Rogers is a diversified public communications and media company. It operates in the field of wireless communication, cable television, telephone, Internet, and holds significant media assets. In 2017, Rogers reported \$14.1B in revenue, and earnings before interest, taxes, depreciation and amortization (EBITDA) of \$5.4B. Excluding spectrum licenses, Rogers spent \$2.44B in capital expenditures in that same year. Rogers is the largest wireless provider in Canada, with 33 percent market share operating under the Rogers, Fido, Mobilicity, Chatr and Cityfone brands. Rogers has a joint network with Videotron covering Quebec and eastern Ontario, and with Bell MTS in Manitoba. [REDACTED] 21(1)(a),21(1)(b)

[REDACTED] 21(1)(a),21(1)(b)

CCM BN0000725

CONSIDERATIONS

3500 MHz Spectrum

Mr. Natale may wish to discuss the ongoing 3500 MHz repurposing process and reiterate the band's importance for 5G. The 3500 MHz band has been identified internationally as the first key band for 5G, and there has been significant pressure from Canadian stakeholders to make this band available for mobile services in Canada. The department's policy objectives for this band include advancing 5G networks, maintaining current broadband services in rural areas, and ensuring a competitive wireless market.

Inukshuk, a joint Bell/Rogers venture, holds 21(1)(a),21(1)(b) of the 3500 MHz spectrum, primarily in urban markets. Xplomet holds 21(1)(a),21(1)(b) and some smaller rural wireless Internet service providers also have licences. In the 3500 MHz consultation launched in June 2018, Innovation, Science and Economic Development Canada (ISED) proposed options for taking back a portion of the licences in order to auction them for 5G use, 21(1)(a),21(1)(b) 21(1)(a),21(1)(b) In its comments, Rogers argued that they should be permitted to keep most if not all of their spectrum. Rogers also suggested that the amount of spectrum auctioned be increased so that current licensees could keep all their licences and the department could still meet its policy objectives. 21(1)(a),21(1)(b)

21(1)(a),21(1)(b)

21(1)(a),21(1)(b)

21(1)(a),21(1)(b)

However, treating Inuksuk this way would result in Rogers and Bell each retaining a large share of the spectrum. 21(1)(a),21(1)(b)

21(1)(a),21(1)(b)

23

23

CCM BN0000725

CRTC High Pressure Sales Tactics Inquiry

In response to the government's order, the CRTC launched an inquiry into the sales practices of large telecommunications carriers on July 16, 2018. During the first phase of written comments, Rogers submitted that the reported issues with sales practices result from the complexity of the market and the services on offer rather than deliberate attempts to mislead or pressure customers. Rogers considers that current protections and regulations in place are sufficient to ensure customers are treated fairly. Like the other large carriers, Rogers also submitted information on its sales practices in response to a detailed CRTC request.

The CRTC will also conduct public opinion research and hold an oral hearing in October, 2018. The CRTC must deliver a report on its findings including potential solutions by February 28, 2018.

Access to Utility Poles

Telecom companies can encounter hurdles to deployment of new facilities such as high rates of access to support structures (i.e. poles and ducts). Cable companies like Rogers have concerns about the Ontario Energy Board approving or planning to approve significant increases to wireline attachment rates for electrical poles, which will make it harder to deploy new infrastructure. The CRTC does not have jurisdiction to set rates access to electrical utility poles, which falls under provincial jurisdiction. The matter of governance of support structures has been put to the independent Broadcasting and Telecommunications Legislative Review Panel to study.

NEXT STEPS

Speaking points are attached as (Annex A). Other key issues that Mr. Natale may raise are also included as (Annex B). A biography of Mr. Natale is also attached as (Annex C).

John Knuble
Deputy Minister

Attachments

CCM BN0000725

**MEETING WITH JOE NATALE, PRESIDENT AND
CEO ROGERS**

Speaking Points

3500 MHz

- The challenge for us is to construct a decision that leads to 5G networks being built in Canada, but maintains the progress we've been seeing in terms of competition within the mobile sector, and still provides a path forward for the smaller service providers that are using this spectrum for rural broadband.
- We understand your positions on the consultation proposals and we are carefully considering all comments.
- We heard from many stakeholders, including Rogers, about the importance of this band for unleashing the potential of 5G. That is why we are moving ahead quickly with our consultation process.

• [Redacted: 21(1)(a), 21(1)(b)]

- The department is reviewing your submission along with everything else we heard in the consultation, with the goal of crafting a decision that's best for 5G deployment, wireless competition, and rural connectivity.

(Responsive to Rogers's request to expand the 3500 MHz Band)

- As indicated in our consultation, we are only looking to introduce mobile services in 200 MHz of the band. We are constrained by rural and Department of Defence users at this time. [Redacted: 21(1)(b)]

[Redacted: 21(1)(b)]

CRTC Inquiry into High-Pressure Sales Practices (Responsive)

- I understand the CRTC's process is now underway. This is an issue that's very important to Canadians.
- We want a thorough examination in order to establish the facts of the matter. Rogers' participation throughout the process will of course be integral to that.
- I can't comment further on the process, which is now in the CRTC's hands. We look forward to seeing the CRTC's findings.

Access to Utility Poles (Responsive)

- We have taken note of your views and understand the importance of reasonable access to support structures.
- Regarding the issue of jurisdiction and the *Telecommunications Act*, as you know, the government has launched a review of the legislation that is being led by an independent expert panel. I would encourage Rogers to participate in the panel's consultation process.

Meeting with Joe Natale, President and CEO, Rogers

Meeting Objective

- The objective of these meetings is to hear about Rogers' position on current telecommunications issues.

Desired Outcome

- To gain a better understanding of Rogers' views on regarding telecommunication issues impacting Canadians such as; 5G, affordability, and competition.

Key Issues / Priority Discussion Items

- 3500 MHz
- CRTC Inquiry into High-Pressure Sales Practices
- Access to Utility Poles

Other Potential Issues

Broadcasting and Telecommunications Legislative Review

On June 5, 2018, the Government launched the review of the *Broadcasting and Telecommunications Acts*. An external review panel was established and given terms of reference outlining the government's priorities and key questions. The panel has since announced that it intends to consult widely with Canadians and will launch this process in September 2018.

Speaking Points

- The Legislative Review Panel stated that it intends to launch a process of consultation in September. What are your priorities for the legislative review? What will you seek to communicate to the panel?
- *(responsive on specific issues)* The government's priorities were outlined in the Terms of Reference. I am looking forward to the Panel engaging with Canadians and their recommendations.

CRTC Wireless Low-cost Data-only Proceeding

In response to the issues raised in the Wi-Fi-First MVNO reconsideration, the CRTC launched a public process to ensure lower-cost data-only wireless plans are available to Canadians across the country, to foster affordability, innovation, and choice in the wireless market. The national carriers submitted plan proposals April 23, 2018. Rogers' proposal included 400 MB of data for \$25. Public advocacy groups, and a number of Canadian individuals, criticized the plans for failing to address affordability concerns. Shaw and Videotron cautioned against heavy regulation. On July 20, 2018, the CRTC requested further information from national carriers and other stakeholders, including Rogers. Deadline for response is September 10, 2018.

Speaking Points (responsive)

- Affordability of wireless services is an ongoing challenge for Canadians which was recognized by the CRTC.
- I am not in a position to comment further on an open proceeding before the CRTC.

Final CRTC Wholesale Wireless Roaming Rates

On May 5, 2015, the CRTC established interim wholesale wireless roaming rates. These are the rates that Rogers, Bell Mobility, and Telus charge smaller wireless companies for wholesale roaming services. The CRTC then launched an evidence based process to set final rates.

On March 22, 2018, the CRTC approved the final wholesale mobile wireless roaming service rates. The final wholesale roaming rates range from 44% to 99% lower than the interim rates, depending on the carrier and the wireless service. As part of the

ANNEX B
CONFIDENTIAL

decision, the CRTC retroactively applied the new rates to the date of their initial decision in 2015. When setting interim rates, the CRTC maintains the power to apply the final rates retroactively to the date of the establishment of interim rates. The CRTC first stated it was considering applying the rates retroactively in a December 2015 decision.

As the final rates are considerably lower than the original rates, this decision resulted in incumbent carriers owing refunds to smaller companies such as Freedom and Videotron.

Speaking Points (responsive)

- Effective roaming rates are critical to supporting the government's goals of competition and investment.
- The CRTC engaged in a detailed evidence-based process to establish the final rates. During this time incumbent carriers, such as Rogers, were able to submit evidence and argue for the appropriate level of the rate.
- The CRTC stated that it would determine whether to make final rates retroactive to 2015. In situations the CRTC deems appropriate, it has the power to apply final rates retroactively.

FairPlay Piracy Website Blocking Proposal

Rogers is a member of the "FairPlay" coalition of media companies that filed an application with the CRTC requesting the creation of a new agency and process for blocking websites that infringe copyright material. The proposal is controversial and many Canadians have filed comments to the CRTC. The written record for the application is now closed and the CRTC will now consider whether it has enough information to make a decision or announce further rounds of consultation. The government should not comment on open proceedings before the independent regulator.

Speaking Points (responsive)

- Thank you for making me aware of your concerns; however, as these are currently before the CRTC, I am not in a position to comment substantively.

Biography:

Joe Natale, President and CEO, Rogers



Joe Natale joined Rogers as President and Chief Executive Officer on April 19, 2017. Prior to joining Rogers, Mr. Natale was President and CEO at TELUS Corporation. He first joined Telus in 2003, holding a number of senior positions including President of Enterprise Solutions, President of Consumer Solutions, and Chief Commercial Officer. Prior to 2003, Mr. Natale held successive senior leadership roles within KPMG Consulting, which he joined after it acquired the company he co-founded, PNO Management Consultants Inc., in 1997.

He currently sits on the Board of Directors at The Hospital for Sick Children, Celestica, Inc., and the campaign cabinet of the United Way Toronto. He is a past recipient of Canada's Top 40 under 40 Award. He holds a Bachelor of Applied Science degree in Electrical Engineering from the University of Waterloo.

Guillemette, Rebecca (IC)

From: Christensen, Michael (IC)
Sent: January 29, 2019 1:06 PM
To: Willis3, David (IC); Guillemette, Rebecca (IC)
Subject: RE: Rogers [redacted] 20(1)(b) CONFIDENTIAL

I've talked to Chantal Davis and she's also looking for previous discussion points on what counts [redacted] 20(1)(b),21(1)(b) This seems to have come up in the context of the [redacted] 20(1)(b),21(1)(b)

[redacted] 20(1)(b),21(1)(b)

This is the best reference I was able to track down to how we've handled this type of question in the past [redacted] 21(1)(b)

[redacted] 21(1)(b)

Any decision on the recent request is complicated by the fact that the current [redacted] 21(1)(a),21(1)(b)

[redacted] 21(1)(a),21(1)(b)

From: Christensen, Michael (IC)
Sent: January-28-19 5:37 PM
To: Willis3, David (IC); Guillemette, Rebecca (IC)
Subject: Re: Rogers [redacted] 20(1)(b) CONFIDENTIAL

We should see if we can track down any correspondence with [redacted] 21(1)(b)

[redacted] 21(1)(b)

I don't still have anything that old but maybe DGSO would have saved something in their official records [redacted] 21(1)(b)

[redacted] 21(1)(b)

From: Willis3, David (IC)
Sent: Monday, January 28, 2019 5:11 PM
To: Christensen, Michael (IC); Guillemette, Rebecca (IC)
Subject: Fwd: Rogers [redacted] 20(1)(b) CONFIDENTIAL

----- Original message -----

From: "Parsons2, Eric (IC)" <eric.parsons2@canada.ca>
Date: 2019-01-28 5:10 PM (GMT-05:00)
To: "Willis3, David (IC)" <david.willis3@canada.ca>

Subject: RE: Rogers [redacted] 20(1)(b) CONFIDENTIAL

From: Willis3, David (IC) <david.willis3@canada.ca>
Sent: January 28, 2019 5:08 PM
To: Parsons2, Eric (IC) <eric.parsons2@canada.ca>
Subject: Re: Rogers [redacted] 20(1)(b) CONFIDENTIAL

Can you forward the attachment.

David

----- Original message -----

From: "Hart2, Susan (IC)" <susan.hart2@canada.ca>
Date: 2019-01-28 4:58 PM (GMT-05:00)
To: "Willis3, David (IC)" <david.willis3@canada.ca>, "Proulx, Martin (IC)" <martin.proulx@canada.ca>, "Sheskay, Glenn (IC)" <glenn.sheskay@canada.ca>
Cc: "Parsons2, Eric (IC)" <eric.parsons2@canada.ca>, "Scott, Adam (IC)" <adam.scott@canada.ca>
Subject: FW: Rogers [redacted] 20(1)(b) CONFIDENTIAL

Hi, I am bringing you in the loop. See below.

Sue

From: Gilfillan, Fiona (IC)
Sent: January-28-19 4:45 PM
To: Hart2, Susan (IC)
Cc: Scott, Adam (IC); Parsons2, Eric (IC)
Subject: RE: Rogers [redacted] 20(1)(b) CONFIDENTIAL

Thanks for the head's up. Please ensure that legal and DGEPS are looking at this too and set up a meeting to brief me when you are ready. [redacted] 21(1)(b)

[redacted] 21(1)(b)

Thanks.

Fiona

From: Hart2, Susan (IC) <susan.hart2@canada.ca>
Sent: January 28, 2019 4:30 PM
To: Gilfillan, Fiona (IC) <fiona.gilfillan@canada.ca>
Cc: Scott, Adam (IC) <adam.scott@canada.ca>; Parsons2, Eric (IC) <eric.parsons2@canada.ca>
Subject: FW: Rogers [redacted] 20(1)(b) CONFIDENTIAL

Hi Fiona, I wanted you to be aware [redacted] 20(1)(b), 21(1)(b) request below. We are working with Adam on this. Sue

From: Parsons2, Eric (IC)
Sent: January-28-19 4:08 PM

To: Hart2, Susan (IC)
Cc: Scott, Adam (IC); Chevrier, Aline (IC); Davis2, Chantal (IC); Lander, Elisabeth (IC); STS DGSO / DGOGS SST (IC)
Subject: Rogers [redacted] 20(1)(b) CONFIDENTIAL

Hi Sue,

Here is an update on the conf call we held earlier today with Rogers. Present on the call were myself, Aline, Chantal, and Lis.

Rogers shared with us [redacted] 20(1)(b).21(1)(b)

[redacted] 20(1)(b).21(1)(b)

Rogers have requested a response in the 2-3 week timeframe, but are open to followup conference calls at any time.

We did not comment [redacted] 20(1)(b).21(1)(b) but did ask a few clarification questions. We will review internally with LS, SLPB, DGEPS during the week and provide an update sometime next week.

Regards,

Eric Parsons

Senior Director, Spectrum Management Operations Branch
Innovation, Science and Economic Development Canada / Government of Canada
Eric.Parsons2@canada.ca / Tel: 343-291-0423 / Cell: 613-762-6557 / TTY: 1-866-694-8389

Directeur principal, Direction générale des opérations de la gestion du spectre
Innovation, Sciences et Développement économique Canada / Gouvernement du Canada
Eric.Parsons2@canada.ca / Tél: 343-291-0423 / Cell: 613-762-6557 / ATS: 1-866-694-8389

From: Joel Thorp [redacted] 19(1) [redacted] @rci.rogers.com>
Sent: January 28, 2019 9:41 AM
To: Parsons2, Eric (IC) <eric.parsons2@canada.ca>
Subject: RE: Request for Call to Discuss [redacted] 20(1)(b) CONFIDENTIAL

Eric,

Attached is a confidential summary [redacted] 20(1)(b) to explain to you during our call at 11:00am.

Thanks and regards,
Joel

From: Joel Thorp
Sent: January 18, 2019 12:44 PM

To: 'Parsons2, Eric (IC)' <eric.parsons2@canada.ca>

Subject: Request for Call to Discuss a [redacted] 20(1)(b)

Eric,

Howard and I would like to brief you [redacted] 20(1)(b) to receive your feedback.

I would be grateful if you could let me know whether you are available for a 30-minute call next week and if you could propose two or three available timeslots for us. Please note that I will not be available on Tuesday afternoon and all of Wednesday.

Thanks and regards,

Joel

Joel Thorp | Director - Spectrum Policy & Strategy | [redacted] 19(1) [redacted] 19(1) @rci.rogers.com
Rogers Communications | 333 Bloor Street East, 9th Floor | Toronto, ON | M4W 1G9

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Guillemette, Rebecca (IC)

From: Davis2, Chantal (IC)
Sent: January 29, 2019 5:04 PM
To: Parsons2, Eric (IC); Lander, Elisabeth (IC); Willis3, David (IC); Chevrier, Aline (IC); Sheskay, Glenn (IC); Guillemette, Rebecca (IC)
Subject: RE: Discuss Rogers [redacted] 20(1)(b)

Sorry I just noticed that Michael sent me something too. I have added it to this version.



Chantal

From: Davis2, Chantal (IC)
Sent: January-29-19 5:01 PM
To: Parsons2, Eric (IC); Lander, Elisabeth (IC); Willis3, David (IC); Chevrier, Aline (IC); Sheskay, Glenn (IC); Guillemette, Rebecca (IC)
Subject: RE: Discuss Rogers [redacted] 20(1)(b)

FYI. I was doing some digging through our policies to see what we have said relating to [redacted] 20(1)(b), 21(1)(b)

<< File: [redacted] 20(1)(b), 21(1)(b) policies.docx >>

Chantal

-----Original Appointment-----

From: Geerts, Philippe (IC) **On Behalf Of** Parsons2, Eric (IC)
Sent: January-29-19 4:51 PM
To: Lander, Elisabeth (IC); Willis3, David (IC); Chevrier, Aline (IC); Sheskay, Glenn (IC); Guillemette, Rebecca (IC); Davis2, Chantal (IC)
Subject: Discuss Rogers [redacted] 20(1)(b)
When: January-30-19 10:00 AM-11:00 AM (UTC-05:00) Eastern Time (US & Canada).
Where: 647A

Please note new location

Best timeslot I could find so far. -Eric

Guillemette, Rebecca (IC)

From: Christensen, Michael (IC)
Sent: January 30, 2019 9:24 AM
To: Guillemette, Rebecca (IC); Willis3, David (IC)
Subject: RE: Discuss Rogers [redacted] 20(1)(b)

Also pertinent (in the ITU Radio Regs but not the Canadian Table):

[redacted] 21(1)(b)

From: Guillemette, Rebecca (IC)
Sent: January-30-19 9:09 AM
To: Willis3, David (IC); Christensen, Michael (IC)
Subject: RE: Discuss Rogers [redacted] 20(1)(b)

Canadian Table of Frequency Allocations:

[redacted] 21(1)(b)

From: Willis3, David (IC) <david.willis3@canada.ca>
Sent: January 30, 2019 8:54 AM
To: Christensen, Michael (IC) <michael.christensen@canada.ca>; Guillemette, Rebecca (IC) <rebecca.guillemette@canada.ca>
Subject: FW: Discuss Rogers [redacted] 20(1)(b)

Are there comparable definitions in the radio regulations that specify the differences [redacted] 21(1)(b)

David

From: Parsons2, Eric (IC)
Sent: January-30-19 8:06 AM
To: Davis2, Chantal (IC); Lander, Elisabeth (IC); Willis3, David (IC); Chevrier, Aline (IC); Sheskay, Glenn (IC); Guillemette, Rebecca (IC)
Subject: RE: Discuss Rogers [redacted] 20(1)(b)

Key are the following:

21(1)(b)

From: Davis2, Chantal (IC) <chantal.davis2@canada.ca>
Sent: January 29, 2019 5:04 PM
To: Parsons2, Eric (IC) <eric.parsons2@canada.ca>; Lander, Elisabeth (IC) <elisabeth.lander@canada.ca>; Willis3, David (IC) <david.willis3@canada.ca>; Chevrier, Aline (IC) <aline.chevrier@canada.ca>; Sheskay, Glenn (IC) <glenn.sheskay@canada.ca>; Guillemette, Rebecca (IC) <rebecca.guillemette@canada.ca>
Subject: RE: Discuss Rogers [redacted] 20(1)(b)

Sorry I just noticed that Michael sent me something too. I have added it to this version.

<< File: [redacted] 20(1)(b) policies.docx >>
Chantal

From: Davis2, Chantal (IC)
Sent: January-29-19 5:01 PM
To: Parsons2, Eric (IC); Lander, Elisabeth (IC); Willis3, David (IC); Chevrier, Aline (IC); Sheskay, Glenn (IC); Guillemette, Rebecca (IC)
Subject: RE: Discuss Rogers [redacted] 20(1)(b)

FYI. I was doing some digging through our policies to see what we have said [redacted] 20(1)(b)

<< File: [redacted] 20(1)(b) policies.docx >>

Chantal

-----Original Appointment-----

From: Geerts, Philippe (IC) **On Behalf Of** Parsons2, Eric (IC)
Sent: January-29-19 4:51 PM
To: Lander, Elisabeth (IC); Willis3, David (IC); Chevrier, Aline (IC); Sheskay, Glenn (IC); Guillemette, Rebecca (IC); Davis2, Chantal (IC)
Subject: Discuss Rogers [redacted] 20(1)(b)
When: January-30-19 10:00 AM-11:00 AM (UTC-05:00) Eastern Time (US & Canada).
Where: 647A

Please note new location

Best timeslot I could find so far. -Eric

Guillemette, Rebecca (IC)

From: Parsons2, Eric (IC)
Sent: January 30, 2019 9:40 AM
To: Lander, Elisabeth (IC); Willis3, David (IC); Chevrier, Aline (IC); Sheskay, Glenn (IC); Guillemette, Rebecca (IC); Davis2, Chantal (IC)
Cc: Souliere, James (IC)
Subject: RE: Discuss Rogers [redacted] 20(1)(b)
Attachments: [redacted] 20(1)(b)

For everyone's reference – see attached. Note confidentiality. -Eric

-----Original Appointment-----

From: Parsons2, Eric (IC)
Sent: January 28, 2019 5:12 PM
To: Parsons2, Eric (IC); Lander, Elisabeth (IC); Willis3, David (IC); Chevrier, Aline (IC); Sheskay, Glenn (IC); Guillemette, Rebecca (IC); Davis2, Chantal (IC)
Cc: Souliere, James (IC)
Subject: Discuss Rogers [redacted] 20(1)(b)
When: January 30, 2019 10:00 AM-11:00 AM (UTC-05:00) Eastern Time (US & Canada).
Where: 647A

Please note new location

Best timeslot I could find so far. -Eric

To: Gallant, Josette (IC)[josette.gallant@canada.ca]; Proulx, Stephane (IC)[stephane.proulx@canada.ca]
Cc: Chamberlain2, David (IC)[david.chamberlain2@canada.ca]
From: Nixon, Jason (IC)
Sent: Tue 10/07/2018 8:21:48 AM
Importance: Normal
Subject: RE: DGEPS - MIMO Project
MAIL_RECEIVED: Tue 10/07/2018 8:21:48 AM
5992-2600EN (5G OTA Keysight).pdf
D Moongilan- IEEE MIMO antenna Far Distance.pdf

Attached is a good white paper from Keysight on OTA testing for 5G. When informal discussions were held with them, they are developing the CATR in the white paper.

Steph, This would be good to give to DME. Also the R&S videos. Benoit's point on the fact that the far field equation may be too far for max EIRP is something I have heard before and his illustration is on point. The only thing he did not address that I have heard. see attached paper by Nokia Labs, is that the Far field actually is still the far field for a single element within the array because the fields actually add faster to the plane wave, supplemented with Benoit's info, the plane wave in the max eirp develops within the far field of a single element, but side lobes would not be accurate.

21(1)(a),21(1)(b)

Jason

From: Gallant, Josette (IC)
Sent: July-09-18 4:59 PM
To: Proulx, Stephane (IC); Nixon, Jason (IC)
Cc: Chamberlain2, David (IC)
Subject: Re: DGEPS - MIMO Project

That's where I initially saw the videos. :-)

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Proulx, Stephane (IC)

Sent: Monday, July 9, 2018 4:55 PM

To: Gallant, Josette (IC); Nixon, Jason (IC)

Cc: Chamberlain2, David (IC)

Subject: RE: DGEPS - MIMO Project

I watched those over the weekend . They are interesting. Although it's quite rare, there is informative and interesting content being shared via Facebook ☺ especially if your friends with folks like Benoit Derat from R&S (used to be with Art-Fi).

-S-

From: Gallant, Josette (IC)

Sent: July-09-18 4:45 PM

To: Nixon, Jason (IC)

Cc: Proulx, Stephane (IC); Chamberlain2, David (IC)

Subject: RE: DGEPS - MIMO Project

Thank you Jason for the input. I see your point for the base stations and HAAT. We will need to work with our colleagues in DME...

On another note, R&S are working on solutions. Here are 2 videos of Benoit Derat from R&S on: Creating far-field conditions at short distances for 5G over the air testing

<https://www.youtube.com/watch?v=eEuNmWjII7k&feature=youtu.be>

<https://www.youtube.com/watch?v=a8ri3HELnHM&feature=youtu.be>

From: Nixon, Jason (IC)
Sent: July-09-18 4:33 PM
To: Gallant, Josette (IC)
Cc: Proulx, Stephane (IC); Chamberlain2, David (IC)
Subject: RE: DGEPS - MIMO Project

Hi Josette,

I mentioned to Steph that the timeline is not really defined yet for ANSI C63.26 publication and I don't think it will happen before the end of 2019.

There will be a KDB first to cover the TRP methodology.

Here is a quick summary I had already sent to Steph.

21(1)(b)

21(1)(b)

Jason

From: Gallant, Josette (IC)
Sent: July-09-18 3:32 PM
To: Nixon, Jason (IC)
Cc: Proulx, Stephane (IC); Chamberlain2, David (IC)
Subject: FW: DGEPS - MIMO Project

Hi Jason,

We had the MIMO meeting last week, and we were wondering what was the timeline for the publication of the ANSI 63.26 with the massive MIMO consideration using TRP. 21(1)(b)

21(1)(b)

21(1)(b)

Many thanks,

Josette

From: Gallant, Josette (IC)
Sent: June-12-18 7:06 PM
To: Nappert, Hughes (IC); Tran, Loan (IC); Saint-Pierre, Greguy (IC); Nixon, Jason (IC); Proulx, Stephane (IC); Losier, Yan (IC)
Cc: Guillemette, Rebecca (IC); Dorrance, Matthew (IC); Olenga, Joel (IC)

Subject: FW: DGEPS - MIMO Project

FYI – Jason provided some recommendations on the MIMO project. Thanks Jason. We will discuss them at the July meeting.

Josette

From: Nixon, Jason (IC)
Sent: June-12-18 8:19 AM
To: Gallant, Josette (IC)
Subject: RE: DGEPS - MIMO Project

Hi Josette,

I am away that week but believe we should be there as we have been dealing with MIIMO and questions about for some time.

21(1)(b)

21(1)(b)

I will have someone else attend in my place, unless you can shift the meeting by a week either way.

Jason

From: Gallant, Josette (IC)
Sent: June-11-18 6:47 PM
To: Nappert, Hughes (IC); Tran, Loan (IC); Saint-Pierre, Greguy (IC); Nixon, Jason (IC); Proulx, Stephane (IC); Losier, Yan (IC)
Cc: Guillemette, Rebecca (IC); Dorrance, Matthew (IC); Olenga, Joel (IC)
Subject: DGEPS - MIMO Project

Hi everyone,

21(1)(a),21(1)(b)

Comments from Outlook Consultation

Rogers raised the need for modernization and flexibility in ISED's policies, frameworks and rules to promote innovation and investment in digital technologies. Rogers indicated that ISED plays an important role in ensuring that Canada continues to be at the forefront of 5G deployments by providing timely access to mobile spectrum, which will help capitalize on technology advancements. They added that modernization and harmonization of ISED's technical standards for bands currently available for commercial mobile services would assist in addressing traffic pressure and demand, so as to take advantage of recent developments in areas such as MIMO and beamforming antennas. Both Facebook and Rogers mentioned some specific updates to technical standards that could be made by ISED.

Outlook Decision

ISED is committed to promoting innovation-led growth across all sectors of the Canadian economy, including capitalizing on technology advancements to give businesses, research institutions and cities a competitive edge. As such, ISED continues to closely monitor the evolution of technology, with a view to ensuring that technical frameworks are flexible enough to facilitate the adoption and deployment of new technologies. In particular, ISED is currently exploring options to update existing technical standards to address the latest developments of MIMO. ISED is conducting an assessment of what other countries are currently doing to address MIMO from a regulatory perspective. This review will result in ISED updating relevant technical standards, which will include consultation with the RABC prior to finalization.

After chatting with Rebecca, we are looking at means of advancing this work more quickly. We will be meeting on July 4th to brainstorm the scope of this MIMO project between DRS and DME (and CEB). I will forward you the invite from Joel shortly.

[redacted] 21(1)(a).21(1)(b)
[redacted] 21(1)(a).21(1)(b) We will be discussing this option at the July meeting. I would recommend that you think about the scope of this project, way forward, etc. so everyone can come prepared with already some recommendations/suggestions.

Some items for us and/or [redacted] 21(1)(b) to consider:

[redacted] 21(1)(b)

The meeting invite will be forwarded your way.

Many thanks,

Josette

PS. CEB, I believe you should be at the table since you are also actively participating in international standard development activities on this topic.

Josette Gallant

Director, Regulatory Standards, Engineering, Planning and Standards Branch
Innovation, Science and Economic Development Canada / Government of Canada
josette.gallant@canada.ca / Tel: 613-797-2253 / TTY: 1-866-694-8389

Directrice, Normes réglementaires, Direction générale du génie, de la planification et des normes
Innovation, Sciences et Développement économique Canada / Gouvernement du Canada
josette.gallant@canada.ca / Tél. : 613-797-2253 / ATS : 1-866-694-8389

Keysight Technologies OTA Test for Millimeter-Wave 5G NR Devices and Systems

White Paper



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Introduction: Millimeter Waves in 5G

To meet the needs of a networked society, next-generation 5G cellular networks promise revolutionary improvements in network capacity, data rates and latency, with greatly increased network flexibility and efficiency. At the same time, network operators will expect lower operational and infrastructure costs than today [1], [2]. Achieving these challenging goals will require extensive and multi-faceted changes in all aspects of the cellular eco-system, from chipsets and devices to base stations and small cells, from front haul and back haul to network management and data center performance. Many new technologies such as network function virtualization (NFV), adaptive beamforming and beamtracking techniques, tight integration with 4G LTE and new designs for mobile devices will be developed to enhance network performance, but by themselves, they will not be sufficient.

Fully realizing the 5G vision will require much additional spectrum. Although additional spectrum below 6 GHz has been identified and, in some countries, already allocated for cellular communications, much larger contiguous spectrum is available in the centimeter and millimeter-wave (mmWave) bands above 24 GHz. Figure 1 [3] shows some of the candidate mmWave bands in various regions of the world for 5G NR (New Radio). For convenience, this document will refer to frequency bands above 6 GHz as mmWave.

Frequencies above 40 GHz are also under consideration for applications such as broadband distribution and backhaul. While arguably not strictly '5G', work in these areas is under way and presents many similar challenges to those of the frequency bands around 28 GHz and 39 GHz, which are driving much of today's 5G NR development.

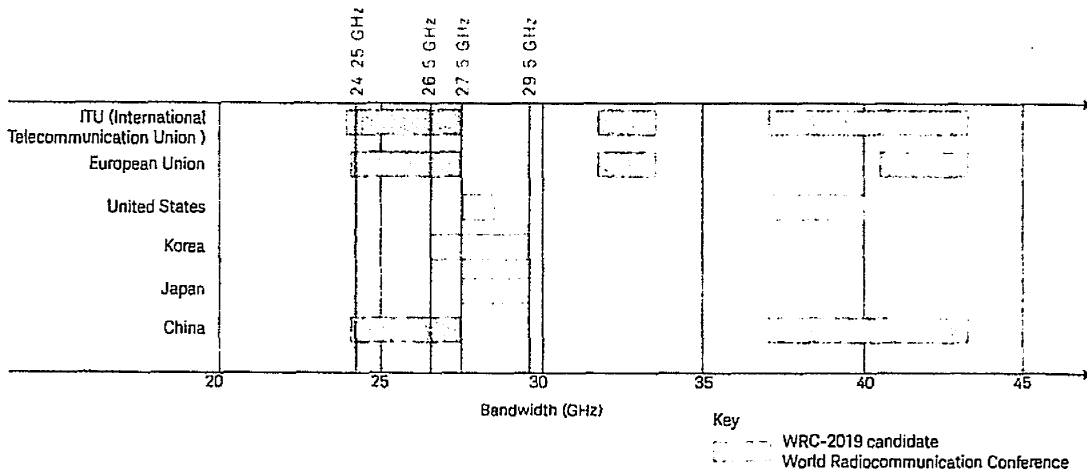


Figure 1. Candidate bands for NR deployment above 6 GHz [3]

The amount of new spectrum that policy-makers are allocating offers a seemingly straightforward path toward higher capacity, higher data-rates, and lower latency. However, any additional mmWave spectrum comes with consequences and trade-offs. Incorporating mmWave devices into the network will introduce new complexity and require new technology development—and will drive new radiated, or over the air (OTA) test requirements. This document will focus on these OTA challenges and the associated test methods.



Technology Challenges for a mmWave 5G Network

Channel sounding and modeling at mmWave

Understanding the transmission properties of mmWaves in real-world environments is fundamental to the core design of the 5G NR UEs and base stations (gNB). As the wavelengths get smaller, physical processes such as diffraction, scattering, material penetration loss, and free space path loss, all make the channel properties of mmWave bands significantly different from today's sub 6 GHz bands. Channel models have been developed over many years from 2G to 4G based primarily on channel measurements (sounding), originally presenting non-spatial models but evolving over time to 3-D spatial models [4].

The 3GPP study on 5G channel model for frequencies from 0.5 to 100 GHz [5] considers several scenarios including Urban Micro, Urban Macro, Indoor, Backhaul, Device to Device (D2D), Vehicle to Vehicle (V2V), and Stadium. The number of spatial clusters and multipath components per cluster in the mmWave channel, and the spatial dynamics, has far-reaching implications on the design of the network components. For example, if the channel model defines a spatially rich channel, the antenna beamsteering requirements are not so important, and many Eigenmodes will be available for Single-User MIMO (SU-MIMO) but the resulting fast fading caused by the addition of so many multi-path signals will be complex. On the other hand, a more sparse channel will contain few Eigenmodes, less fading but require much better beamsteering. This is why realistic channel modeling is important for both device design and defining realistic and useful test cases.

Since the publication of [5] mmWave channel modeling activities have been continuing at companies, universities, and at government institutions in an effort to develop a greater understanding of the mmWave channel and its behavior.

Path loss modeling

Ignoring atmospheric effects, the received power for a transmitter and a receiver communicating via free space is easily calculated using the Friis transmission equation [6] given as Equation 1.

$$\frac{P_r}{P_t} = \left(\frac{c}{4\pi Rf} \right)^2 G_t G_r \quad \text{Equation 1}$$

where P_r is the received power, P_t is the transmitted power, R is the distance between the transmitter and receiver, f is the frequency, c is the speed of light, G_t is the gain of the transmitter antenna, and G_r is the gain of the receiver antenna.

P_r is thus inversely proportional to the square of the frequency, f . For example, moving from 3 to 30 GHz using the same antenna gain adds 20 dB of path loss that, without mitigation, would severely impact network performance. In addition to the free space path loss, OTA communications at mmWave also need to take into account the effects of atmospheric absorption, humidity, blocking, precipitation and other factors which can increase the effective path loss between transmitter and receiver. For indoor channels, path loss is less of a concern but other effects like blocking need to be mitigated.

The mechanism typically employed to overcome additional path loss at mmWave frequencies is to increase the gain and therefore the directivity of the antennas. Base stations in a 5G network are likely to have antennas with > 20 dBi directivity, and user devices (UEs) for 5G are also expected to incorporate directional antennas, though with more moderate directivity. The 3GPP co-existence studies in [7] assume gNB directivity for 30 dBi and UE of 25 dBi although practical UE directivity may be a lot lower unless for



fixed wireless access applications. In addition to countering the path loss of the mmWave channel, directivity also supports spatial reuse of the channel allowing the gNB to support multiple users in one cell with spatially separate beams. A further advantage of directivity is reduced interference to neighbor cells in the network which generally improves spectral efficiency. Consequently, 5G networks utilizing mmWave frequencies will require both base stations and UEs to steer relatively narrow beams toward each other (and via reflective surfaces) to optimize the link budget and provide effective communication. Developing protocols for enabling base stations and UEs to find and track each other and perform inter-cell handovers represents a key technical challenge of mmWave communications for 5G.

Phased Array Technology, Beamforming and Beamsteering

Phased array antennas [8] are a practical and low-cost means of creating narrow beams (beamforming) and dynamically pointing them in the desired direction (beamsteering). They enable beam steering without mechanical motion and are expected to be the principle mmWave antennas used for both base stations and UEs. A phased array antenna is formed by an array of smaller antenna elements, such as individual patches or dipoles. By varying the relative phases and amplitudes of the signals applied to the individual elements, the antenna array can shape and steer a beam in a chosen direction. Figure 2 [9] illustrates the basic operation of a phased array. A signal from a transmitter (Tx) is distributed to several antenna elements. Phase shifters are controlled to adjust the individual phase of the signal transmitted from each element, thereby enabling beamforming at a variable angle theta (θ).

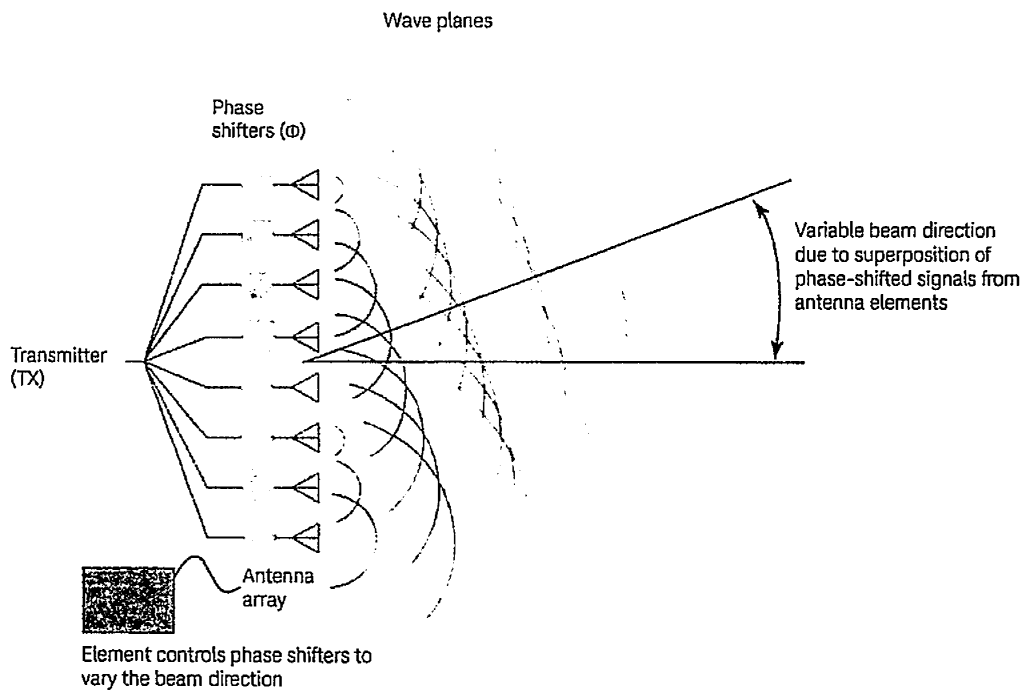


Figure 2. Basic operation of a phased array



Three types of beamforming architectures are being considered for 5G networks: digital (implemented in baseband), analog (implemented at IF or RF), and hybrid [10]. Each has its relative merits. For cost and power reasons, beamforming in UEs is expected to be analog, whereas the beamforming of base stations may be either analog, digital, or hybrid.

Figure 3 shows a Time Domain Duplex (TDD) simulation of propagation from a 50-element linear array with zero-forcing pre-coding. Individual beams are steered to target UEs, while a null is steered towards other UEs and interference sources.

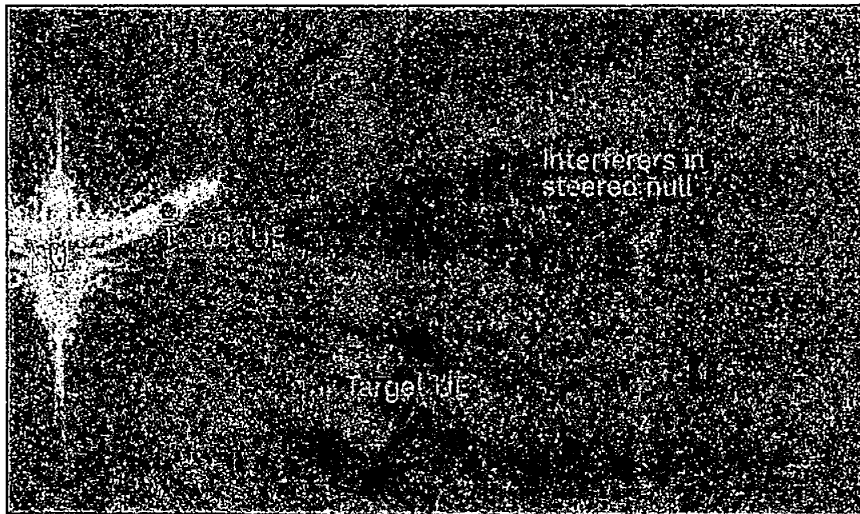


Figure 3. Simulation of a 2-D phased array steering beams to target UEs while steering a null to interfering sources

Radio and Antenna Integration, and the Elimination of RF Connectors

A number of factors contribute to the increasing levels of integration in 5G mmWave devices. These factors are interrelated and are driven by the combination of high frequencies, large numbers of antenna elements, the need to minimize signal path attenuation, and the need to reduce cost. A significant consequence of the resulting integration is that traditional RF connectors at the boundary between the radio distribution network circuit and the antenna system are no longer possible to implement. The distribution network employed to connect mmWave signals from the radio to the antenna must be extremely compact, especially in handheld devices and other user equipment. As a result, transceiver systems for 5G mmWave devices will be directly integrated with the antenna arrays as shown in Figure 4. In these types of devices, there are no longer connectors or probe points that might enable conducted tests; instead, the great majority of testing must now be accomplished OTA.



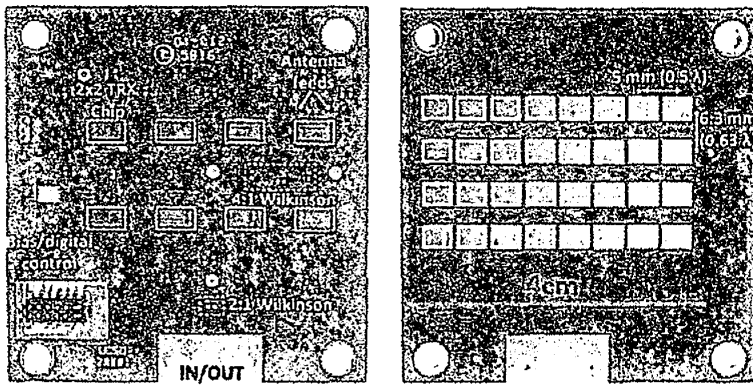


Figure 4. Two sides of a printed circuit board, showing a high level of integration between 28-GHz RFICs and an antenna array. Image courtesy of Professor G. Rebeiz of the University of California, San Diego. [1]

Device Calibration

Establishing a methodology for OTA calibration of the phase and gain states of phased array devices (Tx and Rx paths) is a key R&D activity that necessarily will be performed OTA. Calibration is required to ensure that beams transmitted from UEs and base stations produce the correct beam width or gain over the required range of pointing angles, that power output limits are met, and that beamforming characteristics are operating as intended. These characteristics include coarse/fine resolution scan operation, accuracy of scan angle, and gain flatness compensation.

Which methodology to choose for OTA calibration will depend on the device architecture and the control interface of the device. For example, if each individual antenna element can be controlled independently, then the relative phase between antenna elements can be measured and corrected. If antenna elements can only be controlled in blocks or rows, then more sophisticated calibration routines are required.

New OTA Test Implications of mmWave 5G

The previous sections make it clear that the use of mmWave frequencies for 5G NR systems adds complexity to the devices used in the network and to the operation of the radio access network itself. Test systems will play a critical role in the development and validation of 5G NR, from R&D through conformance test, manufacturing and installation and maintenance. The high level of radio and antenna integration means that much of this testing will be OTA, while the wide variety of test needs (capability, accuracy, size, and cost) requires a correspondingly flexible range of test solutions. The next sections describe OTA test methods for 5G mmWave systems.



Measurement of Radiated Fields

OTA measurements are typically made in either the radiated near-field or radiated far-field regions of the antenna system under test, as shown in Figure 5.

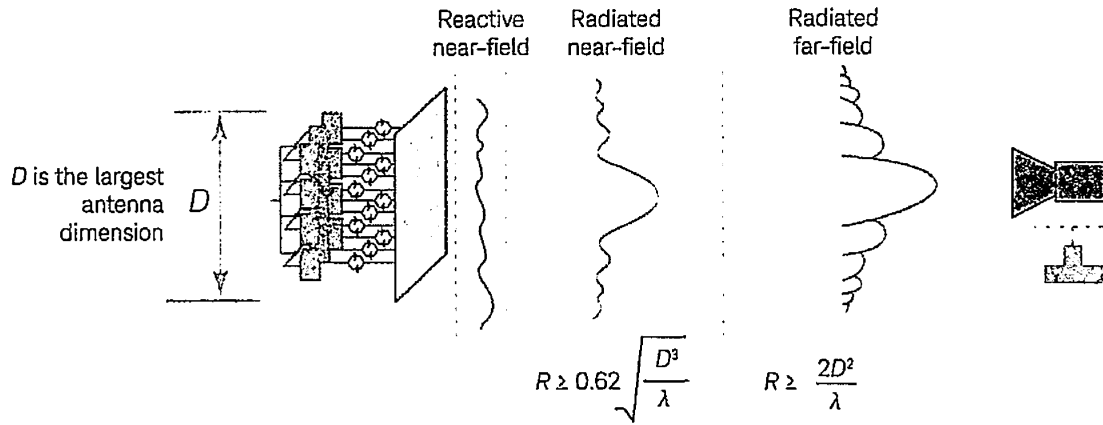


Figure 5. Beam evolution as a function of distance from an antenna

Very near the antenna itself, typically on the order of a few wavelengths or less, is the reactive near-field. In this region, absorption or coupling to objects (e.g., a probe antenna) has an impact on the E and H field components radiated from the antenna. As shown in Figure 5, this region extends to a distance approximately defined as:

$$R = 0.62 \sqrt{\frac{D^3}{\lambda}} \quad \text{where } D \text{ is the diameter of the smallest sphere encapsulating all the radiating elements of the antenna, which may include passive elements.}$$

Beyond this distance, a probe antenna will not affect the signal radiated by the antenna. In the radiated near-field, known as the Fresnel region, the radiated angular field distribution evolves with distance from the antenna, though the evolution slows as the distance grows. The radial components of E and H fields may be appreciable in this region, reducing in strength rapidly with distance R . For antennas where $D \gg \lambda$, the far-field or Fraunhofer distance begins at $2D^2/\lambda$ from the antenna. Beyond the Fraunhofer distance, the E and H field components are transverse and orthogonal, and the radial field components are negligible.

The boundary to the Fraunhofer region is not a sudden transition in the evolution of the radiated patterns. The distribution of radiated power does continue to evolve beyond this distance, so an antenna pattern measured at $2D^2/\lambda$ will differ slightly from the pattern measured much further away, but it is close enough for many OTA test purposes. As the distance increases from the antenna, the amplitude of the peaks, sidelobes, and nulls in its radiation pattern stabilize.



Direct Far-Field Test Method

Measurement in the far-field is conceptually the simplest type of OTA measurement system, and is an approved method identified by 3GPP for base station RF measurements and is the baseline UE RF test method. A typical far-field anechoic chamber is shown in Figure 6.

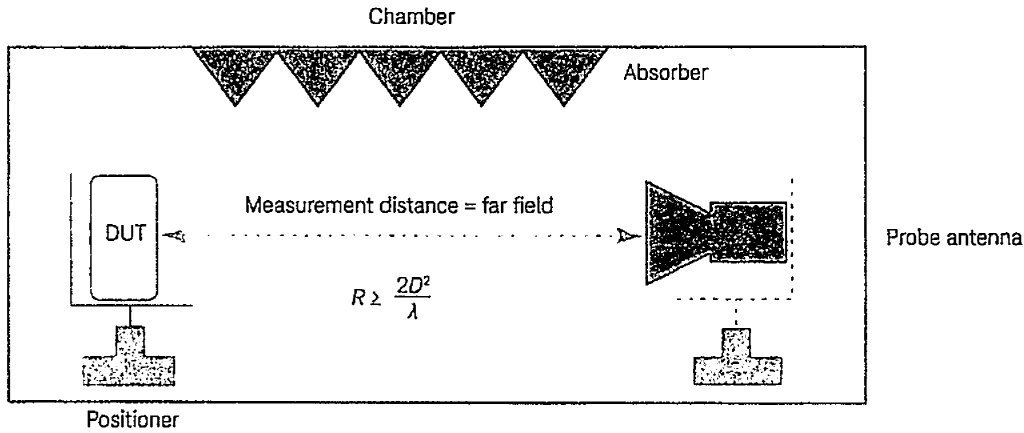


Figure 6. Far-field anechoic chamber

The device-under-test (DUT) is mounted on a positioner that rotates in two planes; azimuth and elevation, or azimuth and roll, to allow any 3D angle to be probed. Some chamber systems deploy an array of probe antennas instead of a single antenna, which can simplify the standard positioner movement at the expense of increased switching and calibration complexity.

From the far-field Fraunhofer distance equation, it can be seen that the far-field distance and therefore the size of the required chamber can vary significantly with antenna size and frequency. Table 1 gives some representative far-field distances at frequencies of interest for 5G. Since the direct far-field chamber must itself be larger than this minimum distance, size and cost of such systems can quickly escalate.

D (mm)	Far-Field Distance (m)		
	28 GHz	39 GHz	60 GHz
50	0.47	0.65	1
100	1.9	2.6	4
150	4.2	5.8	9
200	7.6	10	16
300	17	23	36

Table 1. Far-field distances for antennas of various sizes

Typical active antenna array systems (AAS) for base stations operating at mmWave frequencies can be in the range of 100 mm to 300 mm (depending on whether a sub-array or the entire array is active), requiring direct far-field anechoic chambers to be large room-sized installations. Millimeter-wave 5G UEs will have antenna arrays significantly smaller than 100 mm, making use of direct far-field anechoic chambers more feasible.



However, it is not always straightforward to define the D to be used in the far-field equation. For a typical antenna array, D is the diagonal extent of the array. When that array is incorporated into an UE or a base station, the array may couple to the ground plane behind it and to nearby conducting materials causing the effective radiating area to increase. For mmWave 5G UEs, another complicating factor in determining the value of D is that these devices are anticipated to have multiple antenna arrays to enable full spherical coverage. Multiple arrays also overcome situations where the signal is blocked by a human hand or head [12]. Figure 7 shows examples of possible array placements..

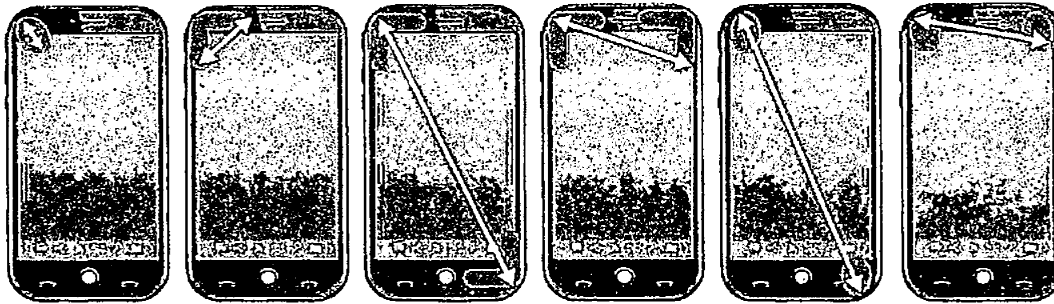


Figure 7. Potential antenna array configurations for a mmWave 5G UE

There are two approaches that can be taken for measuring devices with one or more antenna arrays. The first “white box” approach is based on prior knowledge of the antenna array position on the DUT. This position could be determined either by design, declaration, or near-field scanning. The DUT is then positioned such that the center of radiation is placed at the center of the test zone. The far-field distance can then be calculated with D being set to the largest dimension of the array (assuming no significant ground plane effects). Typical array dimensions would then lead to a far-field distance of much less than 1 m for an UE. To test the entire device requires repositioning the DUT for each array.

The alternative approach does not require knowledge of any antenna array position(s) and is known as the “black box” approach. In this instance, the geometric center of the DUT is placed at the center of the test zone and the D used for calculating the far-field is the maximum dimension of the DUT. The far field for this approach is much larger than for the white box approach (e.g., 4.2 m for a 150 mm DUT at 28 GHz, but the device does not need to be repositioned regardless of which antenna arrays are active.

The use of the white box approach is attractive in a development environment since the far-field distance is much shorter and knowledge of the antenna structure more likely. However, for conformance testing, 3GPP has decided that only the black box approach can be used. This is due to the requirements for white box testing outlined in [13] not being accepted by UE vendors who preferred not to declare the antenna structure. In addition, no mechanism exists for the UE to signal when it changes its array, and the white box approach also rules out use of more than one array at a time.



Alternative Far-Field Test Method – Compact Antenna Test Range (CATR)

The Compact Antenna Test Range (CATR) method is recognized as a standard means for far-field characterization [14]. At least one quasi-optical element, such as a parabolic reflector, is used to collimate radiation from a test probe [15]. The basic configuration and operation are illustrated in Figure 8.

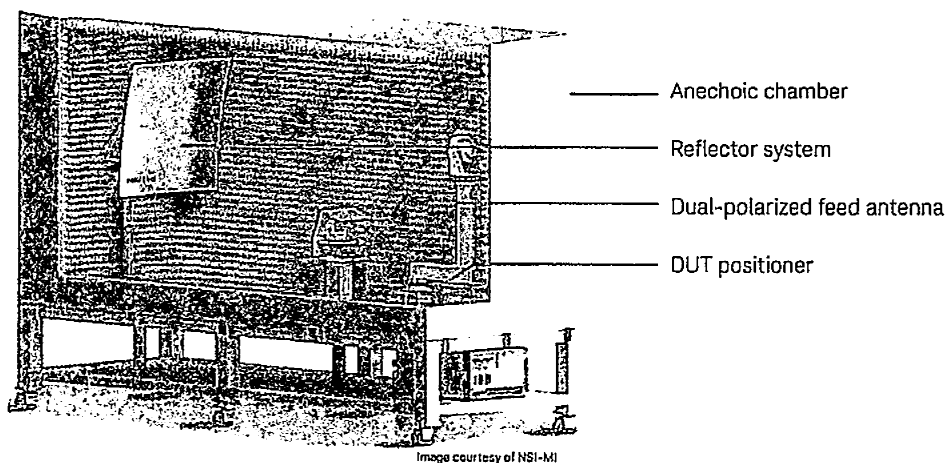


Figure 8. A compact antenna test range.

Figure 8 shows the main elements of the CATR method: a feed or probe antenna, a parabolic reflector system, and a rotating positioner to accommodate the DUT.

A diverging beam from the probe antenna situated at the focus of the mirror illuminates the parabolic reflector, which then collimates the original beam and directs it to the DUT. The collimated beam has a nearly uniform amplitude and phase across its extent; it provides a nominally ideal plane-wave illumination to the DUT. The reflector allows the DUT to be tested under far-field plane wave conditions at a shorter distance than $2D^2/\lambda$, resulting in a system with potentially a much smaller footprint and lower path loss than the equivalent direct far-field method.

The volume in any chamber in which a DUT is illuminated with nearly uniform amplitude and phase is called the quiet zone. In a CATR, the quiet zone is typically cylindrical or elliptical in shape with the diameter or axis set by the extent of the collimated beam within which the phase and amplitude are within particular limits. The zone begins a short distance behind the probe antenna [16]. Typical quiet zone specifications are 10 degrees of phase variation, ± 0.5 dB of amplitude ripple, and 1 dB of amplitude taper, which is the roll-off toward the edges of the quiet zone.

Accurate device characterization requires that the entire radiating volume of the device be within the quiet zone. The rotating positioner then allows characterization of the device or antenna as a function of angle (azimuth and elevation). This configuration is reciprocal so that the device can be measured either in transmit or receive mode without repositioning [17].



Direct Far-Field vs. CATR: Compare and Contrast

Both far-field and CATR methods can provide comparable far-field measurements. Figure 9 shows 28 GHz antenna pattern measurements of a standard gain horn performed in two different chambers. The blue far-field measurements in Figure 9 were performed in a large (> 3 m) direct far-field chamber. The red CATR measurements were obtained using a CATR chamber at Keysight Laboratories. The results are in excellent agreement, where the direct far-field results have sufficient dynamic range for comparison.

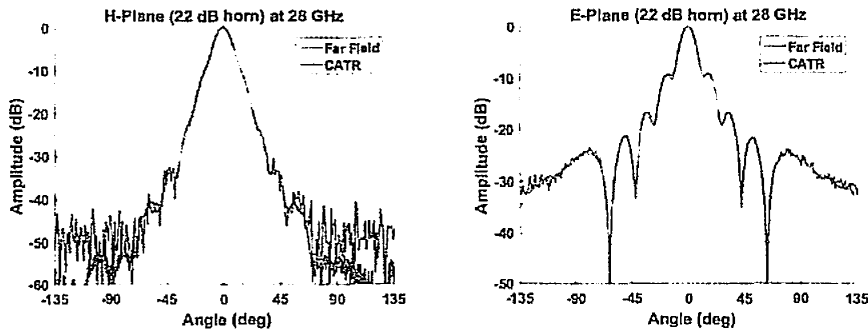


Figure 9. A comparison of CATR and direct far-field measurements

While both the CATR method and the direct far-field method provide far-field device characterization, each has certain performance tradeoffs. The most obvious difference is that CATR measurements can be accomplished in a much smaller footprint when the DUT is electrically large (e.g., for a gNB antenna array operating at mmWave frequencies). Taking the example of a DUT of $D = 300\text{mm}$ at 28 GHz with a far-field of nearly 17 m from Table 1, a CATR chamber whose quiet zone encloses the DUT with some margin would be approximately 3 m long.

With a collimated beam, the CATR provides characterization in the far-field (well beyond $2D^2/\lambda$), which allows for accurate measurements of side-lobes and nulls. However, the parabolic element that enables this compactness also introduces a degree of cross-polarization into the CATR. With proper design, a typical CATR quiet zone can be specified with better than 30 dB of cross-polarization isolation. At that level, the impact on measurements is negligible for many applications.

In the direct far-field method, it is critical that the DUT antenna be placed at the center of the probe antenna's beam. Characterizing a device with multiple antennas at a far-field distance based on the array size would involve repositioning the device so that each array can be characterized. To avoid repositioning, the far-field distance has to be based on the maximum device dimension, resulting in a much larger far-field chamber. With the CATR method, however, all the antennas inside the quiet zone can be characterized simultaneously.

The value of the distance R in equation 1 for path loss (the Friis equation) is different for the two systems. For the direct far-field method, the distance is the separation between the probe and DUT antennas. In the CATR system, however, the relevant distance in calculating path loss is the separation between the probe antenna and the reflector (approximately the focal length). The same path loss, determined by the probe feed to mirror distance, applies whether in transmit or receive mode [17].



In cases where the CATR focal length is shorter than the far-field distance of the DUT, the CATR system will have a lower path loss than the direct far-field method. The total propagation loss of the test system must also include the gains of the probe and DUT antennas. Depending on the antenna gains used in specific setups, a CATR system with lower path loss than a direct far-field system may not always have a lower total propagation loss.

Table 2 summarizes some performance trade-offs between the direct far-field method and the CATR method.

Attribute	Direct far-field	Compact antenna test range
Chamber size	Determined by required far-field distance; Example: 150 mm diameter array at 28 GHz has far-field distance 4.2 m, and chamber length of at least 5.5 m	Determined by required quiet zone diameter; Example: 150 mm diameter array at 28 GHz. Chamber length approximately 2 m
Path loss	Determined by distance between DUT and probe antenna; Example: for a far-field distance of 4.2m at 28 GHz, free-space path loss 74 dB	Determined by focal length of reflector; Example: 150 mm diameter QZ, free-space path loss 58 dB
Cross-polarization isolation	High	~30 dB (curved reflector generates cross-polar component)
Antenna Pattern Measurements	Measurement accuracy of side lobes and nulls is better at larger distances between DUT and probe antenna	Antenna pattern measurements are equivalent to those measured in direct far-field (Figure 9), measurement accuracy of nulls and side lobes depends on QZ flatness
Position of DUT relative to probe antenna beam	White box: Center of radiation of DUT antenna array must be at center of quiet zone. Black box: Geometric center of DUT must be at center of quiet zone	All DUT antenna arrays must be contained within the quiet zone [18]
Cost	Scales with chamber size	Cost of precision reflector offset by smaller chamber

Table 2. Direct far-field vs. CATR



Near-Field Measurement Systems

Near-field measurement systems sample the phase and amplitude of the electrical field in the radiated near-field region (Figure 5), also known as the Fresnel region, over a two-dimensional surface using high-precision positioners. This surface is either planar, cylindrical, or spherical (Figure 10). The far-field antenna pattern is then calculated using Fourier transform algorithms.

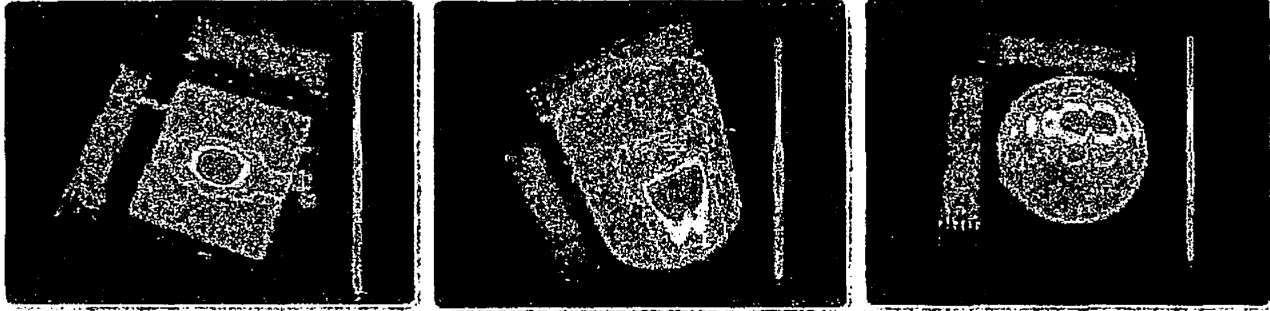


Figure 10. Near-field scanning images in planar (left), cylindrical (middle), and spherical (right) surfaces. Power and phase are measured at each scan point.

Image courtesy of NSI-MI

This approach for antenna pattern measurements can be achieved with relatively small test chambers which are considerably less expensive than indoor far-field ranges. Measurement accuracy and the calculated far-field antenna patterns can compare very well with far-field methods. [19]

Which type of near-field system is best for a particular application will depend on the antenna characteristics of the device to be tested. Mathematically, the planar surface method is the most straightforward; it is well-suited to measurements of directional antennas with minimal backward lobe typical of many mmWave 5G gNB antenna arrays. Planar systems also allow the use of mechanical surface alignment to ensure accurate parallel movement of the scan probe with respect to the DUT array surface. For some 5G DUTs, spherical or spherical-spiral (“sphiral”) scan systems perform measurement of the DUT in a nearly-complete sphere around the DUT, allowing measurement of radiation from the edge or back of the array under test as well as in the main lobe. Cylindrical scan systems can be well-suited to antennas arranged in a linear fashion or a sectorized layout.

Once the electric field is measured at each point in the grid, the data undergoes a Fourier transform to obtain a linear combination of plane waves at various angles. These plane waves, represented in a spherical coordinate system, provide the far-field antenna patterns [15]. This is a transform from near-field measurements at multiple positions to far-field angular patterns [20]. In the case of the planar scan system, the extent of the scan is typically significantly larger than the DUT itself, and this extent used to set the angular resolution in the far-field. Accurate far-field results require compensation for the directive properties of the probe antenna.

Near-field scanning is useful as a diagnostic tool in R&D since transforms can also be applied that reveal the distribution of surface currents on an antenna array, and identify faulty elements or other conditions. Near-field scanning can also be a relatively fast measurement method – several techniques to reduce the required sample set have been developed [21], including the sphiral scan with data interpolation (Figure 12).

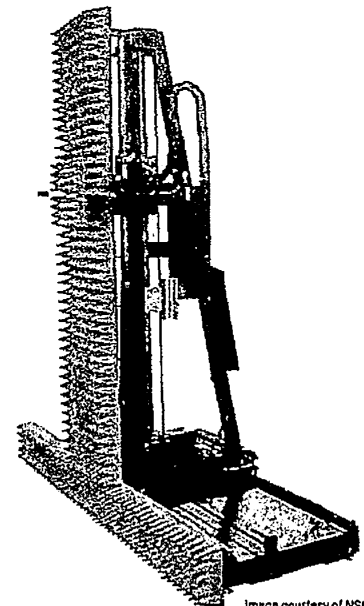


Image courtesy of NSI-MI

Figure 11. Planar near-field scanner by NSI-MI with a 1 m by 1 m scan area.



While the near-field to far-field approach offers the most compact means for antenna characterization, it does pose challenges for mmWave device characterization. For example, a fast vector network analyzer (VNA) is typically used in near-field measurements because both phase and amplitude information are required for the mathematical transformations. However, unlike antennas, mmWave 5G devices are single-ended so will not support the use of a VNA. The high level of integration between the radio and the antenna array mean characterization of only the device antenna may not be possible due to lack of connectors.

Several techniques are available for recovering phase in single-ended devices. One technique requires the measurement of the electric-field amplitude on two different near-field surfaces. This information is applied iteratively with an initial estimate of the phase on a surface to retrieve the unknown phase. With the measured amplitude and derived phase on a surface, the far-field antenna pattern can then be derived [23]. Another technique uses several probe antennas where one or more antennas remain fixed to provide a reference for phase recovery while the other(s) perform a near-field scan. The relative phases measured by the two sets of antennas are then used in the far-field transformation [24].

When measuring mmWave NR devices in the near-field, the far-field transformation for antenna pattern measurements becomes problematic when a wideband modulated signal is transmitted, since the phase can vary across the signal. Traditionally, near-field antenna pattern measurements are performed using CW signals. However, simulated and real data show that the antenna patterns of wideband modulated signals measured in the far-field can show some differences compared with CW patterns, particularly in side lobe level (higher than CW for modulated) and null depth (less deep than CW for modulated). To measure these antenna patterns accurately may require either a far-field or CATR chamber, or measuring the phase of each subcarrier and combining the resulting data.

The applicability of near-field scanning to calculate far-field Tx patterns is clear and involves sequential measurement of the near field followed by post-processing of the Fourier transform. The applicability of near-field for receiver testing is less obvious. For receiver testing that involves real time measurement of throughput, the inverse of the transmitter measurement procedure would require real time generation of a spatial near field signal. This is not practical as the near-field system can probably generate only one point in space. One solution to this problem is to take a two-stage approach by first measuring the receiver near field antenna pattern with the assistance of amplitude and phase measurements in the DUT followed by a second stage where the transformed far-field Rx antenna pattern is applied to the test signal [25]. This approach also extends to applying a spatial channel model to the test signal.

Measurement Requirements through the 5G NR Development Lifecycle

The types of measurements required for 5G NR devices varies throughout the development lifecycle. For example, during the design and development phase, R&D teams aim to measure as many RF characteristics of their devices as possible. Those measurements which can be performed will depend on the particular device and the stage of development of its features and functions, and will also depend on the level of integration of the device under test.

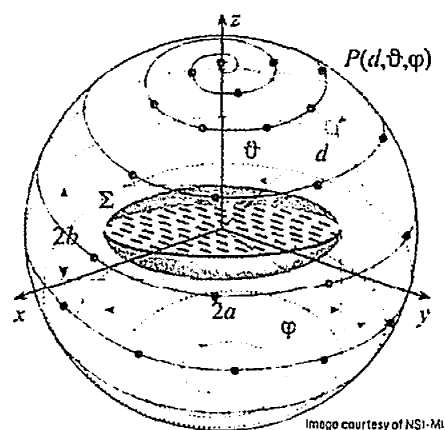


Figure 12. Spherical spiral (spherul) scanning for a quasi-planar DUT [22].



In any communications system, transmitted and received signals are never ideal. A mmWave transmitter chain adds nonlinearities, noise and other impairments to the desired baseband signal to be transmitted. Likewise, the receiver adds distortions and impairments that degrade the received signal. To understand the behavior of mmWave transmitter and receivers it is necessary to characterize their performance over the air using test equipment that can generate and analyze wideband 5G waveforms. It is known that achievable OTA accuracy is not as good as conducted accuracy, so this is an important discussion at 3GPP.

Not all R&D measurements will apply equally to base stations and UEs, and test procedures and performance requirements will be different depending on the device being measured. Table 3 lists the draft 3GPP Technical Specifications for radio transmission and reception of NR UE's and base stations. The documents listed are currently skeleton documents containing headings but limited detail.

Documents	UE	Base Station	
	TS 38.101 User Equipment (UE) radio transmission and reception	TS 38.104 Base Station (BS) radio transmission and reception TS 38.141 Base Station (BS) conformance testing	
Radiated transmitter tests	Transmitter power	Radiated transmit power	
	Output power dynamics	Base station output power	
	Transmit signal quality	Output power dynamics	
	Output RF spectrum emissions		Transmit ON/OFF power
			Minimum output power
	Spurious emissions		Transmitted signal quality
			Occupied bandwidth
			Adjacent channel leakage ratio (ACLR)
			Operating band unwanted emissions
			Transmitter spurious emissions
		Transmitter intermodulation	
Radiated receiver tests	Diversity characteristics	Sensitivity	
	Reference sensitivity power level	Reference sensitivity level	
	Maximum input level	Dynamic range	
	Adjacent channel selectivity	In-band selectivity and blocking	
	Blocking Characteristics	Out-of-band blocking	
	Spurious response	Receiver spurious emissions	
	Intermodulation characteristics	Receiver intermodulation	
Suprious emissions	In-channel selectivity		

Table 3. 5G NR radio transmission and reception test requirements



In general, OTA measurements in R&D will also include the following:

- Beam pattern measurements in both 2D and 3D, to measure beam width, side lobe levels, null depths, and symmetry.
- Cross-polar measurements, to understand the level of cross-polar isolation of the antenna system
- Beamsteering or null steering performance, to confirm that the beam (or beams for base stations) can point in the correct direction while maintaining the correct gain pattern over the desired steering range.

Testing Over Extreme Conditions

UEs and base stations must be tested over extreme conditions including temperature. The operating temperature range for a base station situated outdoors can extend from -60C to +45C, so OTA measurement techniques need to be developed to enable this type of characterization. The challenge for this type of testing is to accurately control the temperature and humidity for the device's immediate environment, while ensuring the OTA measurement system is kept within its much narrower specified operating range.

Measuring Adaptive Behavior

Far more challenging than static RF measurements are tests of a dynamic nature in which the adaptive functionality of the device is measured, and these require a signaling link to be established between devices. An example of this would be measuring the ability of a base station to acquire and spatially track an UE or several UEs, all of which are transmitting and receiving using narrow mmWave beams.

The integration of steerable antennas is fundamental to the function of 5G NR systems, but presents a number of formidable test challenges. The requirements and test methods for measuring adaptive behavior are under discussion at 3GPP.

NR Conformance Testing

Conformance testing happens relatively late in a product's lifecycle and refers specifically to ensuring the device meets 3GPP minimum requirements. 3GPP conformance tests can be grouped into RF, Radio Resource Management (RRM), demodulation, and signaling. The first priority in 3GPP is developing the UE and gNB core requirements by December 2017. The performance requirements (demodulation and RRM test cases) will follow by December 2018.

At the time of writing, discussions on core requirements and specification structure for Release 15 are not yet finalized, so a summary of requirements and test methods is out of scope for this document. Once these requirements are specified, future publications will describe them in detail.

Manufacturing Test

Requirements for manufacturing test are driven by the need to establish confidence that the manufacturing process and supply-chain ensure devices meet conformance and other non-standardized requirements. For that reason, manufacturing test processes are limited to those parameters that are expected to vary. They are limited in scope principally by cost of test and test speed. Key device specifications must be verified while keeping the overall test time and complexity to acceptable levels.



Factors to consider in developing a manufacturing test strategy will include the following:

- Minimizing the time spent on measurements over multiple spatial dimensions (compared with cabled test with no spatial dimension).
- Reduced or eliminated angular-dependent measurements.
- Fast OTA antenna and transmitter/receiver calibration and verification.
- Minimized or no mechanical positioning movement.
- Deployment of small and inexpensive chambers or enclosures.
- A means to cope with the increased measurement uncertainty of OTA measurements compared with cabled measurements.

Like most manufacturing systems, test coverage and test time will be expected to reduce over time. Aggressive goals are already being set to achieve cost of test and throughput targets that will serve to mitigate inherent test time increases associated with the move from cabled to OTA test.

Conclusion

The push into mmWave frequency bands to access new spectrum for 5G NR is creating an abrupt and significant shift in the way commercial communications devices and systems will be designed and verified. Measurements that were previously implemented using cabled connections are moving to the radiated spatial domain; active beamforming systems, steerable arrays and highly integrated designs will require that virtually all testing at mmWave must be done using radiated OTA methods.

In this document, the key challenges in making mmWave OTA measurements have been highlighted, and an overview of the main RF OTA test methods described. Due to the range of test requirements across the design and validation lifecycle, no single test method can fully cover all possible tests.

5G NR is evolving rapidly, and OTA measurements are an integral part of the success of the next generation of cellular systems.



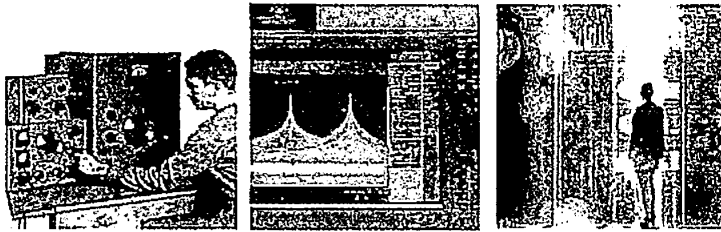
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Wireless MIMO Base Station Near and Far Field Measurement Challenges

Dheena Moongilan

Nokia Bell Laboratories
Murray Hill, NJ 07974, USA

Abstract—Wireless communication systems use Multiple Input Multiple Output (MIMO) antenna techniques to increase coverage, data throughput and spectral efficiency. Frequently, beamforming techniques are used to provide additional antenna gain relative to Single Input Single Output (SISO) systems. Wireless devices with non-detachable antennas, the regulatory compliance must be achieved through radiated emissions tests. Radiated measurements above 1 GHz (at 3 meters' test distance) create further complications because long conductors and slots generate near-field radiation conditions beyond 3 meters. This paper examines near and far-field conditions for MIMO antennas and a transmitter systems and suggests how radiated emissions testing could be improved.

Keywords—Special International Committee on Radio Interference (CISPR); European Telecommunications Standards Institute (ETSI); Federal Communications Commission (FCC); Multiple Input Multiple Output (MIMO); Near-Field; Propagation loss.

I. INTRODUCTION

A Multiple Input Multiple Output (MIMO) transceiver system uses identical multiple transmit and receive chains with independent antennas to improve data throughput, enhance spectral efficiency, and reduce interference and fading. Each transmit path of a MIMO system radiates identical frequencies. In beamforming, both the amplitude and phase of each antenna element are constructively controlled to create a radiation pattern in which the lobes are directed toward the desired directions and the nulls directed in the undesired or interfering directions. Because of this directed signal, the interference to other users is considerably reduced. The multiple receive streams are weighted and summed to maximize the data throughput performance. The MIMO system can deploy several transmit and receive paths, and is often associated with the term spatial diversity. Another technique is spatial multiplexing which exploits multi-transmit paths including reflections to achieve higher data rates. MIMO antenna beamforming systems that use spatial multiplexing and space-time coding [1] for increasing the spectral efficiency (bps/Hz) were not considered in this discussion. For illustrative purposes, both a simple two antenna MIMO beam forming system (Figure-1) and a Multiple Input Single Output (MISO) system (Figure-2) were considered in this paper. MISO uses multiple transmit paths similar to MIMO, but data are received through only one antenna.



Figure-1: MIMO Wireless System.

MISO systems are examples of transmit diversity. In a MISO system, the same data stream is transmitted using multiple transmit antennas and the receiver is then able to receive the strongest signal. All regulatory compliance radiation testing techniques can be considered analogous to MISO systems because radiated emissions testing uses only a single receive antenna. The receive antenna during the test may encounter several spatially different beams of the same frequency. The test procedures are formulated to measure the strongest signal at the specific frequencies and bandwidths.



Figure-2: MISO Wireless System

In a MIMO system, controlled beamforming only occurs in the far-field. If legal compliance measurement distances (3m or 10m) are not sufficiently far for the development of the far field pattern, then the resulting radiation characteristics are complex and difficult to predict. Antennas having a relatively wide beam width are typically used for compliance test measurements. These antennas have lower gain with small apertures. Consequently, they will have shorter near-field distances. Therefore, the measurement antenna would detect the (complex weighted) sum of all the radiated transmissions within the beam width at the same frequency. Since, each transmit path of a MIMO hardware system is identical, the harmonics, local oscillator frequencies, and bandwidths of the different transmissions are also identical. This results in the emergence of beams with the same frequency from the radiating slots, seams, and conductors. However, these transmit paths do induce phase differences which, in beamforming, is intentional

(i.e., by design). Therefore, the field levels detected by the measurement antenna can vary depending on the radiated beam characteristics, phase angle differences, and measurement distances. It is possible for the detected radiated power measured near the equipment under test (EUT) ($< 3\text{m}$) to be lower than the power measured at a larger distance ($> 3\text{m}$) from the EUT. Similarly, radiating emissions from MIMO transmitters could be lower than a single radiating transmitter. This paper examines the complexities of MIMO wireless system radiated emissions and the measurement challenges related to high frequency near-fields. Data measured from MIMO antennas and a transmitter system in an absorber-lined shielded room is presented and discussed.

II. BASIC ASSUMPTIONS

Far-field antenna gain and Friis free propagation loss equations are indiscriminately used in near-field power calculations. The mutual coupling between antennas is assumed to be negligible.

III. THEORY

Near-Field Challenges: The regions immediately surrounding and in close proximity to the antenna are called the reactive and radiative near-field regions, respectively. The angular distribution of the radiated fields in these regions varies with distance. The radiative near-field extends beyond the reactive near-field region. Beyond the near-field regions, the free-space angular distribution of radiating fields is independent of the distance from the antenna, and is called the far-field region. These regions are not strictly defined; however, the commonly accepted boundaries delineating these regions are as follows [2]:

The non-radiating, reactive near-field extends up to $\lambda/2\pi$.

The radiating near-field extends to $2D^2/\lambda$ (1) where,

D is largest dimension of either the transmitting or receiving antenna aperture [3]

λ is wavelength of the transmit frequency.

The near-field radiation patterns of certain simple radiators such as straight uniform wires, loops and aperture antennas can be determined analytically. However, radiating near-fields of real products are typically complex. The radiated patterns may vary considerably in qualitative form and quantitative magnitude from one field point to another [4]. Therefore, the antenna gains and factors for any measurement antenna will be different for near-field and far-field applications. Additionally, establishing the relationship between antenna gain and antenna factor in the near-field is not trivial.

MIMO Near-field Radiation: For a simple case of 2×1 MISO consisting of two transmitters excited with equal in-phase RF power and a receiver (See Figure 4), the radiating near-field should exist in three zones. Specifically:

- the near-field zones surrounding each of the two transmit antennas, and

- the interactive near-field zone between the transmit and receive antennas.

For the case of a single transmit and receive antenna (Figure 3), if the receive antenna is located at a large distance from the source (transmit) antenna or has an aperture that is very small compared to the spherical surface of the radiated power field, the received field appears flat and approximately parallel to the aperture of the receive antenna. However, when a receive antenna aperture is large and intercepts radiated fields with significant angular variation within the antenna dimension "D" of Equation-1 (AB of Figure-3), the net received field is reduced due to differences in path lengths introduced by the angular variation in the spherical surface segment of intersecting wave front. The latter is indicative of near-field conditions, while the former is characteristic of far-field conditions.

In the case of two transmit antennas with shorter separation (L_{sep} in Figure 4) distances, when the receive antenna (RX) is located precisely midway between the 2 transmit (Tx) antennas (i.e., at $L_{sep}/2$), at the same near-field distance as single Tx antenna case, it intercepts angular fields from two antennas. But the angular variation would be less than the single transmit antenna because it intercepts smaller spherical segment surfaces from each of the Tx antennas.

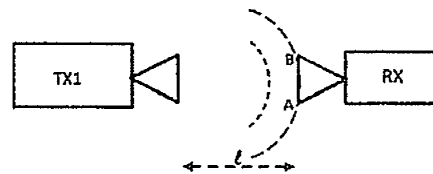


Figure 3 Angular Field of a Single Transmit Antenna Intercepted by a Receive Antenna

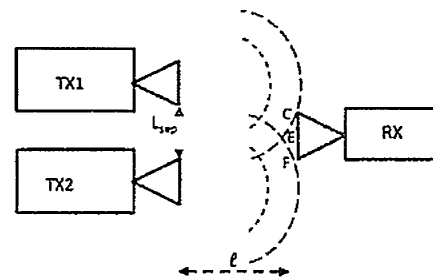


Figure 4 Angular Fields of Two Transmit Antennas Intercepted by a Receive Antenna

As shown Figures 3 and 4, the solid angle subtended by $\hat{AB} > \hat{CE}$ and \hat{EF} . For highly correlated radiated signals, the \hat{CE} and \hat{EF} would be in-phase and would combine. In Figure 4, the receive antenna would also encounter energies from several small spherical segment surfaces of larger circumference wave fronts (not shown Figure 4) which is not available for the single

transmit antenna case. Therefore, the received energy level would be higher for two correlated Tx antennas. Consequently, the far-field extends toward the transmit antennas. If the separation distance (L_{sep}) decreases, the solid angle of \hat{c}_e and \hat{e}_F also decrease with increase in combined power and, the far-field distance from the transmit antennas decreases further. If L_{sep} is large, then the near-field distance from the transmit antenna increases with decrease of energy into the receive antenna. The radiation characteristics become similar to single transmit antenna case. For highly correlated two Tx antenna, depending on the L_{sep} the combined received maximum power level would be twice the single Tx antenna radiated levels. If L_{sep} is very small, the mutual coupling between Tx antennas would dominate resulting in lower received power levels.

The decrease in far-field distance for MIMO systems can also be explained using Schelkunoff's antenna equivalence theorem which is based on Huygens principles [5]. Accordingly, a secondary new wave front can be constructed from the source (transmit) antenna wave fronts. The secondary wave front will have a larger circumference and therefore receive antenna would encounter lower angular fields.

Near-field Radiation from Seams and Slots of Equipment Under Test (EUT): The CISPR and ETSI Radio type approval in addition to FCC regulatory compliance radiated emissions requirements are specified at 3m and 10m distances for the frequency range from 30MHz to 1000MHz. Above 1000MHz, the specified radiated test distance is 3m. If the radiating conductor or slot length is sufficiently long, the radiating near-field can extend beyond the mandated 3m distance. Using equation (1), a plot of free space conductor/slot lengths that can radiate with a near-field zone extending to 3m for the frequency range of 1GHz to 10GHz is shown in Graph-1. If an EUT contains radiating conductors or slot lengths greater than lengths indicated in Graph-1, the measurement distance must be greater than 3m to minimize near-field effects. For example, if the linear radiating slot length exceeds 40cm, the radiated measurements made at 3m for frequencies above 3GHz (see Graph-1) could be in the near-field.

IV. FCC COMPLIANCE TESTING FOR MIMO TRANSMITTERS

The FCC has provided guidance for the antenna port conducted emissions measurements. This guidance is applicable to both licensed and unlicensed devices that transmit on multiple antennas simultaneously in the same or overlapping frequency ranges through a coordinated process. In addition, in-band, out-of-band, and spurious antenna conducted emission measurements are also covered by this FCC guidance. Accordingly, the harmonics and the spurious emissions must be attenuated below the transmitter power (P) by at least [6, 7]

$$43 + 10 \log (P) \text{ dB} + 10 \log_{10} (\text{Number of participating MIMO antennas}) \quad \text{---- (2)}$$

where,

P is power in watts for a single transmit antenna port.

For transmitters that use co-polarized antennas, the sum of the Effective Isotropically Radiated Powers (EIRPs) or Effective Radiated Powers (ERPs) (total or spectral density) must be below the limit consistent with Equation (2). However, radiated measurements are performed with all transmitters operating, and extra steps are not required. Since beamforming of co-polarized MIMO transmitters takes place in the far-field at any given distance, the radiated beams may not be in the far-field at the standard measurement distances (3m or 10m). At these distances, the resulting radiation "pattern" due to near-field effects is extremely variable with distance and is difficult to predict. The MIMO system can radiate different beam patterns depending on the needs of the network.

V. NEAR-FIELD OF A 2X1 MISO ANTENNA SYSTEM MEASUREMENTS

Near and far field radiated power levels were measured using three identical ridged wave-guide antennas at various measurement distances at 2 GHz. The approximate half power beam width of the antennas was 60° for both E and H planes. The EIRP at the transmit antenna was calculated using the following equation:

$$\text{EIRP at the transmit antenna} = \text{Power measured (dBm) at receive antenna} + \text{cable loss (dB)} + \text{propagation loss (L) (dB)} - \text{measurement antenna gain (dBi)} \quad \text{---- (3)}$$

where,

the propagation loss is as defined in (4) below.

The propagation loss was calculated using the Friis free space narrowband propagation path loss equation [3, 9].

$$\text{Free space propagation loss (L)} = 20 \log_{10} (\text{measurement distance (} \ell \text{) in meters)} + 20 \log_{10} (\text{frequency in MHz}) - 27.56 \text{ dB} \quad \text{----(4)}$$

The Friis equation is applicable to the far-field conditions only. However, for some near-field readings in this study, the EIRP calculations were made using the Friis equation and the near-field data is plotted for illustrative purposes only.

A. Radiated power levels were measured using three antennas:

- Two transmit antennas separated by a distance (L_{sep}) and a third antenna as a receive antenna. All the antennas were co-polarized and were placed 2.5m above the ground plane. Since the beam-width of the antennas were larger, it was necessary to place the antennas at least 1.5m above ground plane to minimize ground reflections. The 6dB beam width of the antenna was approximately 1.25m above the ground plane.
- The receive antenna was bore sighted to the middle of the separation distance (L_{sep}) between the transmit antennas. RF absorbers were also placed at the measurement area to create near free-space.
- Both transmit antennas were excited with equal CW power with no phase difference from a signal generator at 2GHz. The received power was measured.

- Initially, the receive antenna was positioned at a far-field distance (3m). The receive antenna was then moved towards the transmitting antenna in increments of decreasing distance to a final position of 5cm.
- Received power was measured at these distances.
- This procedure is repeated by varying the separation (L_{sep}) between the transmitting antennas.
- Transmitted EIRP was calculated from the received power using Friis equation and the resulting data was plotted.

B. Radiated power levels were measured using two antennas:

- One transmit and another as receive antenna.
- Similar to three antennas, measurements were made for different receive antenna distances.
- Transmitted EIRP was calculated from the received power using Friis equation and the resulting data was plotted. Since the plot is similar to $L_{sep} = \lambda$ of Graph-2, a separate graph was not provided.

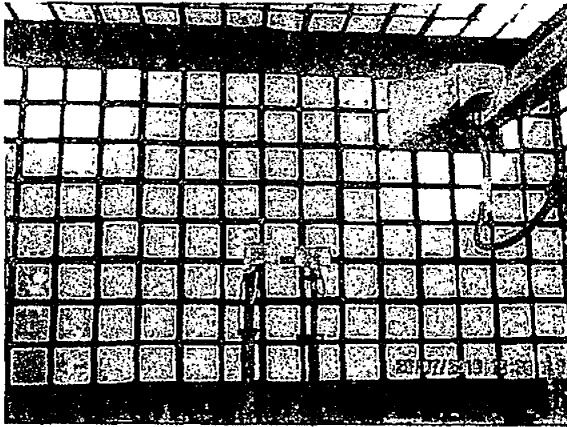


Figure-5 Near-Field Measurement Setup for 2 Transmit Antennas

VI. RADIATED EMISSIONS MEASUREMENTS

Measurement of Spurious Radiated Emissions from a Transmitter Cabinet: Third harmonics radiated by 2100 MHz, MIMO, 2x2, transmitters were tested in a FCC registered 10m absorber-lined shielded room. RF absorbers were placed on the ground plane between the product and the measurement antenna to reduce ground plane reflections. The test was performed in accordance to ASC63.4 [8]. All measurements were made using a spectrum analyzer. The antenna ports were terminated with 50Ω loads. There were three transmit circuit packs in the cabinet each can operate in 2x2 MIMO mode. A part of a gasket was removed from one side of a circuit pack to create a radiating slot. The slot width was very small ($< 2\text{mm}$).

The tests were performed first with an approximately 25cm long gasket removed from an operating circuit pack with only one transmitter was "ON". The tests were made for 2.5, 2.75, 3.0, 3.25, 3.5, 3.75, 4.0, 4.25 and 4.5m test distances. Next,

similar measurements were made with two transmitters operating in the MIMO mode on the same circuit pack. Finally, an approximately 30cm long gasket was removed and tests were repeated with both one and two transmitters operating. Using Friis free space propagation loss equation (4), the calculated power levels (Equation-3) at the transmitters were plotted in Graph-3.

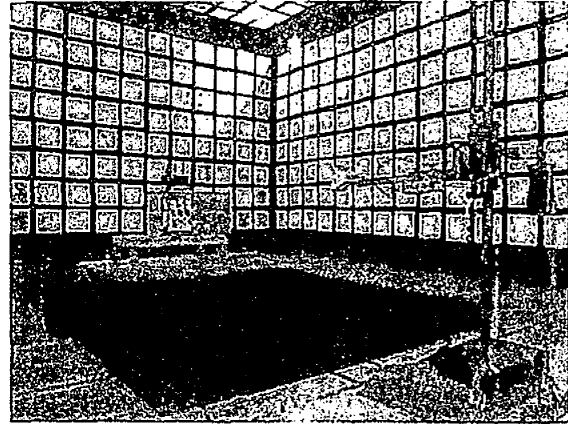


Figure-6 Radiated Emissions from Different Slot Lengths of a Single and Two Transmitters of a 2x2 MIMO System

VII. RESULTS

The minimum conductor/slot lengths required to produce the radiation transition from near-field to far-field at 3m measurement distance was calculated using equation (1) is shown in Graph-1 for the frequency range of 1GHz to 10GHz. Graph-2 provides radiated emissions from two transmit antennas operating with highly correlated in-phase power at 2GHz. The graph shows that near-field distance decreases with separation distance. For this test case, near field distance decreases linearly according to the following equation:

$$\text{Near-Field distance (m)} = 4.5 \times (\text{separation distance in m}) + 0.39$$

Graph-3 provides EIRP levels at 6450MHz (Third Harmonics) radiated through 30cm and 25cm slots of a 2100MHz, 2x2, MIMO transmitter measured in an absorber-lined shielded room using a double ridged wave-guide antenna. Measurements show that the 25cm slot radiates higher than the 30cm slot. The current distribution on a longer slot tends to produce more lobes resulting in a slightly smaller radiated power in the main lobe. According to equation (1), for 6450 MHz radiation, the slot length must be smaller than 26.4cm for the far-field conditions to exist at the 3m distance. The single transmitter radiation plots show that the far-field radiation occurs at 3.6m for the 25cm slot and at 3.7m for the 30cm slot. Similarly, for two transmitters, far-field radiation occurs at 3.15m for 25cm slot and 3.4m for 30cm slot. These measured far-field distances are slightly higher than the values predicted by Equation (1) and shown in Graph-1. This discrepancy is due to the approximate nature of Equation (1).

VIII. CONCLUSIONS

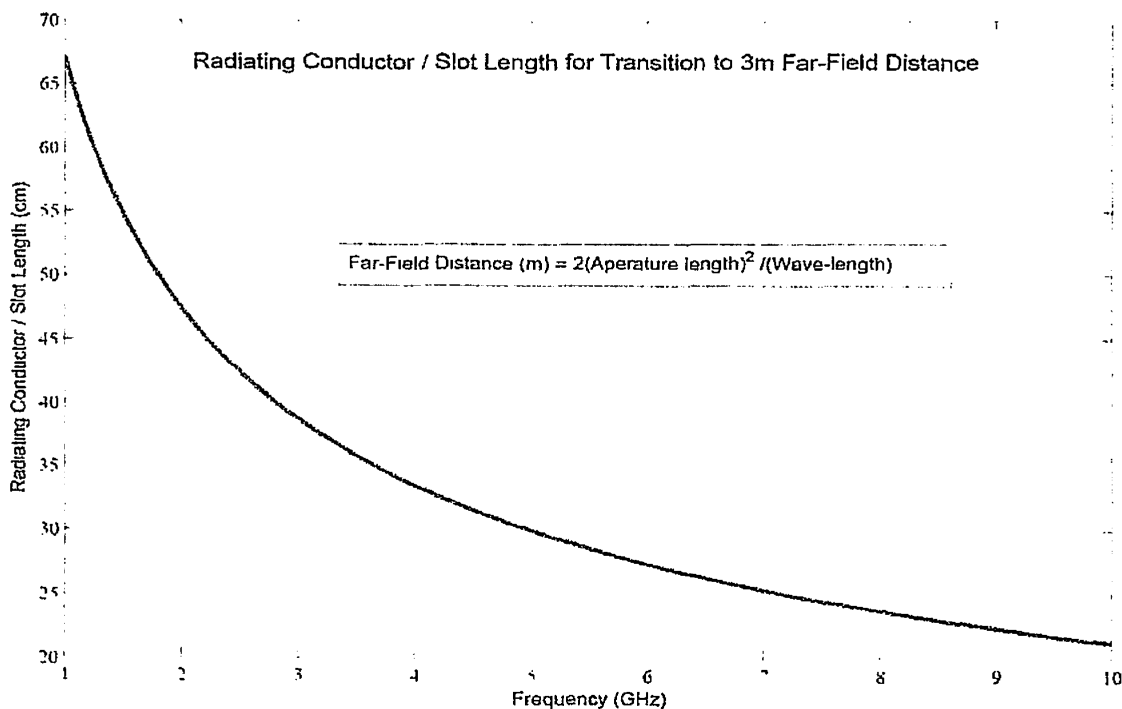
The radiated near-field distances were investigated on two antenna MISO systems and a MIMO base station product. The near-field occurs at shorter distances for a MIMO system than a SISO system. The MIMO system can generate numerous antenna patterns depending on the number, separation and their phase differences. It is very difficult to predict near-field MIMO system behavior for all possible radiating modes. Radiated emissions measurement using a single transmitter with a specification limit based on a FCC sanctioned relationship (Equation (2)) could reduce the complexity of radiated emissions testing for MIMO systems. Regarding spurious emissions, if the radiating slot (or a cable) is long, MIMO transmitter radiation measurements experience both phase cancellation and near-field problems. To improve the test repeatability, emissions that are closer to limit should be investigated at the far-field distances. Measurements of MIMO systems above 1GHz should be made at greater than 3m distances, to assure far-field conditions. The radiated power levels computed at the product for different distances using Friis free space propagation loss equation should be approximately constant. This determines whether measurements are made at far-field conditions and could minimize the near-field measurement errors.

ACKNOWLEDGEMENT

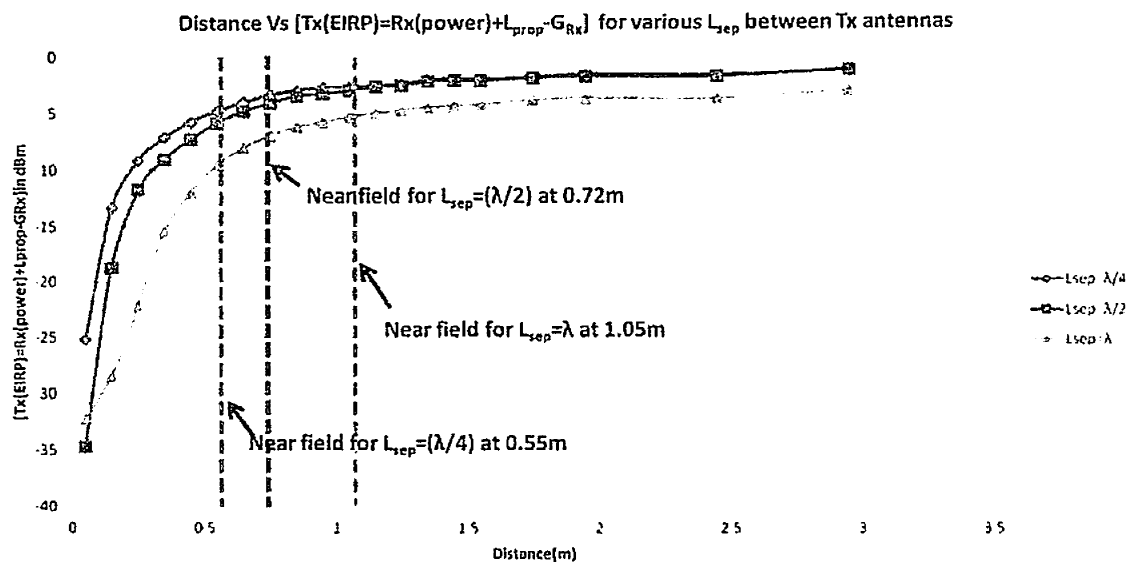
Author wishes to acknowledge Mahesh Srinivasan, PhD student, University of Texas at Austin for assisting in this project as a summer intern

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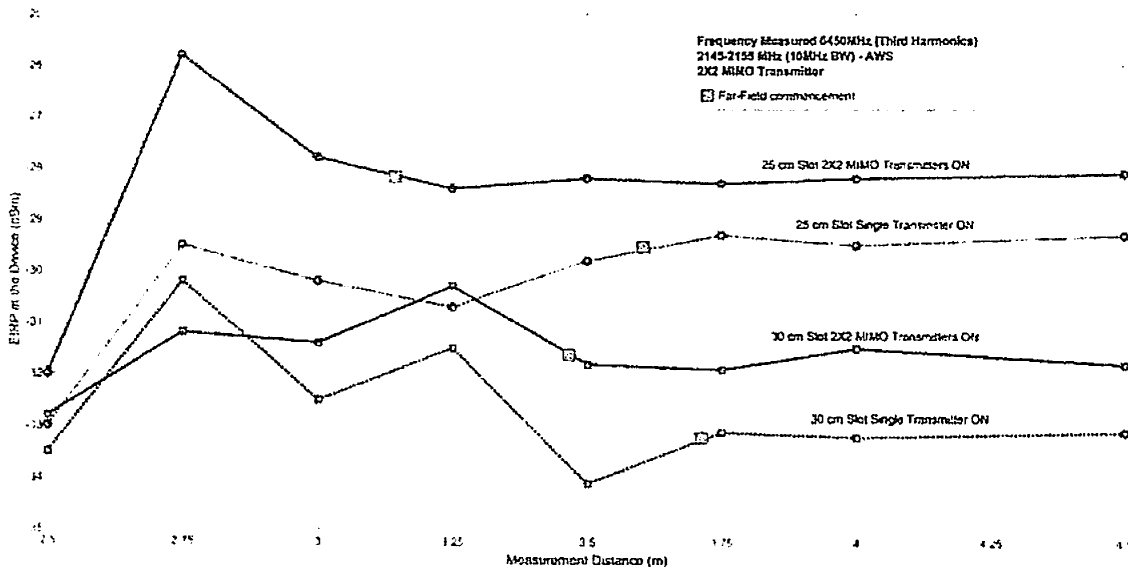
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Graph-I Radiating Conductor/Slot Length for Transition from Near-Field to Far-Field at 3m



Graph-2 Near-field Distance Evaluation for Two Ridged-wave guide Transmit Antennas at Different Separation Distances (L_{sep})



Graph-3 Radiated Emissions of 6450MHz (Third Harmonics) Measured for a 2100MHz MIMO Transmitter in an Absorber-lined Shielded Room using a Double Ridged Wave-guide Receive Antenna

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MAIL_RECEIVED: Wed 29/08/2018 3:49:00 PM
MI Ad-hoc 5G and IoT Rev0.1.pptx

Jason Nixon

Telecommunications Test and Measurement Technologist, Engineering, Planning and Standards
Branch

Innovation, Science and Economic Development Canada / Government of Canada
jason.nixon@canada.ca / Tel: 613-990-6551 / TTY: 1-866-694-8389

Technologue en essais et mesures, Direction générale du génie, de la planification et des normes
Innovation, Sciences et Développement économique Canada / Gouvernement du Canada
jason.nixon@canada.ca / Tél. : 613-990-6551 / ATS : 1-866-694-8389

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From: Nixon, Jason (IC)
Sent: July-20-18 1:57 PM
To: Beaudoin, Claude (IC)
Subject: RE: [REDACTED] 69(1)(g)re(a)

Hi Claude,

Here is my document and the market intel piece from Josh

Jason

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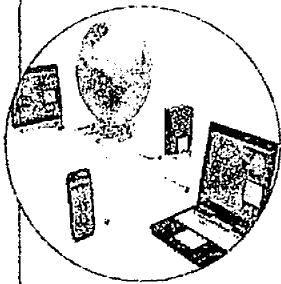
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July 19, 2018

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CEB Market Intelligence Forecast – 5G and IoT

Growth in spectrum



"For 5G technology to work as Canada's carriers hope, they will need huge blocks of spectrum" — for devices such as smartphones, sensors and other connected devices.

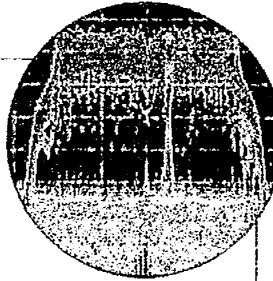
- BNN Bloomberg (June 20, 2018)

Information and Communications Technology Council (ICTC) — a Canadian digital economy not-for-profit — "5G white paper reiterates need for improved access to 600MHz, 3.5GHz spectrum"

- Mobile Syrup (June 5, 2018)

The FCC is planning millimeter wave spectrum auctions in 2018 and 2019. "Licenses for millimeter wave frequencies in 24, 28, 37, 39 and 47 GHz bands focus of proposed auctions. The multi-gigabit speeds 5G is designed to support will require large swatches of high-capacity, millimeter wave spectrum."

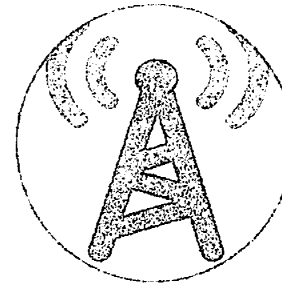
- RCR Wireless News (July 12, 2018)



5G Small Cells

In the United States "300,000 small cells need to be deployed in the next three to four years to serve 5G networks". Modernization of infrastructure guidelines will be key to decreasing the time required for a 5G network rollout.

- CNA (July 19, 2018)



Rogers announced that the company is making "steady progress" towards an eventual 5G network deployment. "We're working with Ericsson, the North American 5G partner of choice, to densify our network with small and macro cell sites."

- Mobile Syrup (July 19, 2018)

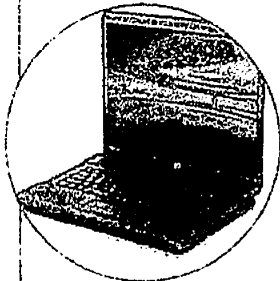
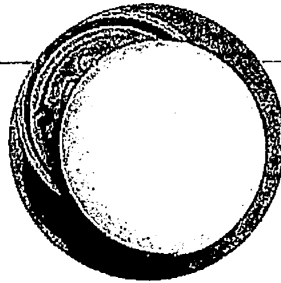
Mobile 5G means "putting it in the small cell sites that boost coverage in busy areas." Qualcomm is launching a 5G platform that brings gigabit data speeds to small cells. It can handle 5G on both regular frequencies and millimeter wave.

- Engadget (May 21, 2018)

CEB Market Intelligence Forecast – 5G and IoT

Wireless market devices

Because 5G-enabled smartphones are not expected to be available until 2019, AT&T plans to introduce a **puck-shaped device to allow users to access the 5G network with their current phones.** – Reuters (July 20, 2018)

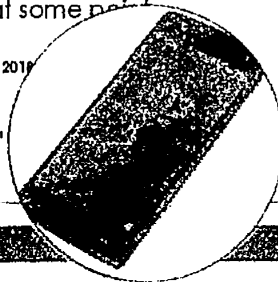


"Sprint and Intel say they'll offer **5G PCs next year**" ... Acer, ASUS, Microsoft, Dell, HP, and Lenovo are all supposed to release 5G laptops and 2-in-1s at some point next year.

– The Verge (June 5, 2018)

OnePlus commits to releasing a **5G-capable smartphone in 2019**"

– Canadian Tech News (June 28, 2018)



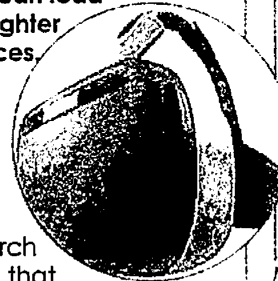
5G and smart glasses: An Augmented Reality (AR) demonstration from Ericsson hints at "how a faster wireless connection **can lead to slimmer, lighter mobile devices.**

That's a big deal for smart glasses."

– CNET Magazine (March 1, 2018)

ABI Research "forecasts that almost 10% of industrial smart glasses and standalone Virtual Reality (VR) devices **will have a 5G connection by 2026**".

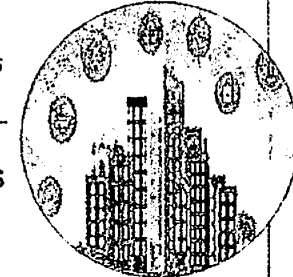
– ABI Research (July 9, 2018)



Integration into verticals

"5G provides the essential prerequisites for smart cities ... hard-working but low-energy **smart city water pressure or GPS sensors** get their own dedicated space in the network."

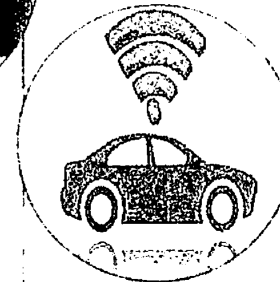
– Mobile Syrup (April 11, 2018)



5G will make **delivery of content faster for autonomous cars.**

They are "going to do something we humans typically pride ourselves on: communicate."

– Mobile Syrup (May 29, 2018)

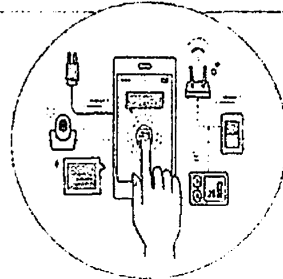


CEB Market Intelligence Forecast – 5G and IoT

IoT expansion

Alongside its plan to launch a 5G network early next year, **Sprint is launching an LTE Cat M network** customers can use to connect and manage devices from all kind of networks, from cellular to Wi-Fi to LoRa.

- *Fierce Wireless* (May 25, 2018)



Licensed low-power, wide-area (LPWA) connections will see a **CAGR of 53 per cent in the period to 2023**, driven by growth in smart meters and asset trackers. NB-IoT and LTE-M will capture more than 55 per cent of LPWA connections.

- *Enterprise IoT Insights* (June 11, 2018)

A recent forecast released by Mobile Experts predicted that **NB-IoT will claim 57% of cellular IoT shipments by 2022** as demand for cheaper, lower-powered services and devices ramps up.

- *Fierce Wireless* (June 20, 2018)

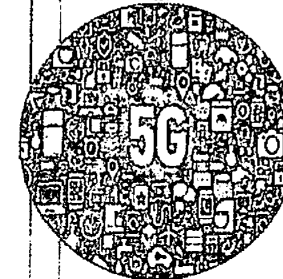
Analyst firm IDC expects worldwide IoT spending to **witness CAGR of 13.6% over the next five years** to reach a total of \$1.2 trillion in 2022.

- *Zacks Investment Research* (July 5, 2018)

US carrier Verizon saw its revenues from 'internet of things' (IoT) based services **climb 13 per cent in the first quarter**, compared with a year ago, almost double the rate of growth across all of its operations.

- *Enterprise IoT Insights* (April 25, 2018)

Future impact

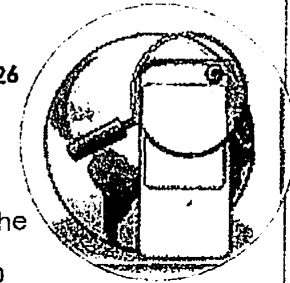


"New 5G wireless networks will contribute as much as **\$40 billion annually to Canada's economy by 2026**, according to a new report from Accenture."

- *RCR Wireless News* (June 26, 2018)

Nearly half of the **Canadian mobile connections by 2026 will be on a 5G connection**, according to new research commissioned by the CWTA.

- *The Wire Report* (June 20, 2018)



To: Salas, Tania (IC)[tania.salas@canada.ca]
From: Salas, Tania (IC)
Sent: Tue 31/07/2018 2:43:54 PM
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Market Highlights

Date: July 31, 2018

Top Stories

Canadian Carriers Told to Stop Selling Alcatel U50 Due to Radio Frequency Exposure Concerns

A smartphone sold by French hardware manufacturer Alcatel has been pulled from Canadian shelves following a failure to comply with federal regulations.

<https://mobilesyrup.com/2018/07/27/canadian-carriers-told-to-stop-selling-alcatel-u50-due-to-radio-frequency-exposure-concerns/>

Nokia to Partner with Current for Smart Cities Platform in Canada

Nokia and Current, a subsidiary of General Electric (GE), will partner to bring GE's smart cities platform, called CityIQ, to Canadian cities.

<https://www.smartcitiesdive.com/news/nokia-to-partner-with-current-for-smart-cities-platform-in-canada/528545/>

Nokia, T-Mobile US Agree \$3.5 Billion Deal, World's First Big 5G Award

T-Mobile US named Nokia to supply it with \$3.5 billion in 5G network gear, marking concrete evidence of a new wireless upgrade cycle taking root.

<https://uk.reuters.com/article/us-telecoms-5g-nokia-t-mobile-us/nokia-t-mobile-us-agree-3-5-billion-deal-worlds-first-big-5g-award-idUKKBN1KK1IK>

New and Interesting on the Canadian Market

Rohde and Schwarz Receives Certification for High Frequency Security Scanner

Rohde and Schwarz received certification for the QPS201 quick personnel security scanner. The unit is a body scanner that operates in the 70 GHz range.

https://www.rohde-schwarz.com/ca/product/aps-productstartpage_63493-332676.html

5G

Xplornet preps for 5G rollout in 2020 with Eastern Ontario fibre investment

Rural fixed wireless and satellite internet provider Xplornet is preparing for its first 5G offerings with a new fibre deployment jointly funded by the government.

<https://mobilesyrup.com/2018/07/25/xplornet-preps-for-5g-rollout-in-2020-with-eastern-ontario-fibre-investment/>

New 5G Antennas Could Be the Boost Smartphones Needed

Qualcomm said it has developed breakthrough antenna technology that will help power uber-fast speeds in next-generation 5G smartphones.

<http://www.govtech.com/network/New-5G-Antennas-Could-Be-the-Boost-Smartphones-Needed.html>

Pivotal Achieves 1.3 Gbps in Echo 5G Field Trial

In-building penetration has always been a challenge for millimeter wave deployments, but Pivotal Commware just completed a field trial at 28 GHz that achieved throughput of 1.3 Gbps using its Holographic Beam Forming (HBF) technology.

<https://www.fiercewireless.com/wireless/pivotal-achieves-1-3-gbps-echo-field-trial>

Trade Groups, Industry Execs Plead For More Spectrum to Spur 5G

While 5G networks hold the promise of speeds that will be 100 times faster than today and enable 100 times the number of devices, carriers and stakeholders providing wireless and wireline infrastructure, as well as the satellite industry, say they need access to more spectrum.

<https://insidetowers.com/cell-tower-news-trade-groups-industry-execs-plead-spectrum-spur-5g/>

Artificial Intelligence (AI)

We've Unleashed AI; Now We Need a Treaty to Control it

The complexity of AI science may lead policymakers and the public to believe the tech industry is best positioned to decide the future of AI yet certainly the issues AI raise should not be left to commercial interests.

<https://www.winnipegfreepress.com/opinion/analysis/weve-unleashed-ai-now-we-need-a-treaty-to-control-it-489080681.html>

Cybersecurity

COSCO Restores Service 5 Days After Cyberattack

COSCO Shipping said Monday its "network applications in the Americas have been totally recovered" after a cyberattack last week disabled systems in the U.S., Canada, Panama, Argentina, Brazil, Peru, Chile and Uruguay.

<https://www.supplychaindive.com/news/COSCO-cyberattack-restores-service/528897/>

With Hacking of U.S. Utilities, Russia Could Move from Cyberespionage Toward Cyberwar

Even before the revelation on July 23 that Russian government hackers had penetrated the computer systems of U.S. electric utilities and could have caused blackouts, government agencies and electricity industry leaders were working to protect U.S. customers and society as a whole.

<http://www.govtech.com/security/With-Hacking-of-US-Utilities-Russia-Could-Move-from-Cyberespionage-Toward-Cyberwar.html>

Internet of Things (IoT)

Self-Installing IoT Hardware Reduces Deployment Costs 66% for Building Owners

The high labor costs of installing digital IoT hardware and measuring devices in large multi-tenant commercial office buildings have prohibited the adoption of the technology, but now a new self-installing IoT solution is about to change that.

<https://inbuildingtech.com/smart-buildings/iot-hardware-sensors-building/How-Intel-is-Using-Industrial-Internet-of-Things-IIoT-Edge-Computing-to-Reduce-Factory-Downtime-by-300%>

Semiconductor maker Intel has applied predictive maintenance to monitor the health of its fan filter units (FFUs) in its semiconductor production facilities through deployment of industrial IoT (IIoT) sensors and edge computing.

<https://enterpriseiotinsights.com/20180724/channels/use-cases/how-intel-is-using-iiot-edge-computing-to-reduce-downtime-tag40-tag99>

Public Safety

AT&T updates on FirstNet, gigabit LTE and 5G

AT&T is investing more than \$40 billion in construction of a nationwide LTE network prioritized for use by first responders and other public safety users.

<https://www.rcwireless.com/20180730/carriers/att-updates-firstnet-5g-tag17>

Regulation

Mobile Carriers Spend More than \$510 Million in Spanish 5G Tender

Spanish operators Telefonica, Orange and Vodafone have secured 200 megahertz in the 3.6 GHz-3.8 GHz band.

<https://www.rcwireless.com/20180727/5g/mobile-carriers-spend-over-510-million-spanish-5g-tender-tag23>

Satellite

LEO Projects Promise Rural, Remote Broadband in Just a Few Years

Three years after a number of big companies first announced they would launch global low-earth-orbit (LEO) systems that would provide internet connectivity to remote areas around the world that space is getting crowded — including with some Canadian competition.

<https://thewirereport.ca/2018/07/27/leo-projects-promise-rural-remote-broadband-in-just-a-few-years/>

Smart Cities

Surveillance, Transport, Lighting Top for Smart Cities, as Total Spending to Jump 95% by 2022

By 2022, global spending on smart city technologies will reach \$158 billion, up 95 per cent from \$81 billion in 2018, and solutions for intelligent traffic management will usurp street lighting as the third most purchased technology by value in the next five years.

<https://enterpriseiotinsights.com/20180725/channels/news/surveillance-transport-lighting-top-for-smart-cities-tag40>

Smart Transportation

BlackBerry CEO Urges U.S. Senate to Pass Driverless Car Legislation

BlackBerry CEO John Chen has signed a letter addressed to members of the U.S. Senate, urging them to pass legislation that will be game changing for self-driving cars.

<https://www.itbusiness.ca/news/blackberry-ceo-urges-u-s-senate-to-pass-driverless-car-legislation/103348>

Waymo, Walmart Partner for Autonomous Vehicle (AV) Shuttle Program in Phoenix

Waymo, the autonomous vehicle (AV) arm of Google parent company Alphabet, announced it is beginning a pilot program with Walmart in Phoenix to take customers to and from its stores to pick up groceries.

<https://www.smartcitiesdive.com/news/waymo-walmart-partner-av-shuttle-program-phoenix/528705/>

Columbus, Ohio, Launches Connected Vehicle Project

Connected vehicle technology is coming to Columbus, Ohio, in the hopes of making a large swath of the city safer for motorists as well as pedestrians and cyclists.

<http://www.govtech.com/fs/transportation/Columbus-Ohio-Launches-Connected-Vehicle-Project-.html>

British Columbia Wildfire Service Says Drone Interference Halted Wildfire Containment

The British Columbia Wildfire Service was compelled to issue a stern caution against flying drones above a wildfire after the issue forced air operations to halt on July 22nd. The B.C. Wildfire Service said it was forced to temporarily halt air operations on a wildfire in Wilson Creek due to people operating unmanned aerial vehicles above the fire.

<https://mobilesyrup.com/2018/07/24/bc-wildfire-service-says-drone-interference-halted-wildfire-containment/>

UK Proposal Sets Minimum Age for Drone Use

The UK government could ban kids from owning drones weighing over 250g (0.55 lbs), under rules drawn up by the Department for Transport. The proposals suggest children could fly a heavier drone under adult supervision if someone older owns and has registered it.

<https://www.engadget.com/2018/07/26/uk-government-kids-drone-ban-drones-bill/>

telecom

Rogers Enhancing Wireless Service in Brampton, Port Dover, Qualicum Beach, Regina and Medicine Hat

The carrier delivered the news in a series of July 26th, 2018 media releases, explaining that the network improvements are part of a "multi-year national network plan to bring next generation wireless services to Canadians, including gigabit LTE network and 5G with future-ready technology and equipment that is based on the latest global 3GPP standards, including 4x4 MIMO, four-carrier aggregation and 256 QAM."

<https://mobilesymp.com/2018/07/26/rogers-enhancing-wireless-service-in-brampton-port-dover-qualicum-beach-regina-medicine-hat/>

More OnGo Test Labs Added as Citizens Broadband Radio Service (CBRS) Ramps to Commercialization

The regulatory process is (hopefully) nearing an end, trials are ongoing and commercial products are being put through their paces as the telecom industry preps for deployment of LTE in the 3.5 GHz Citizens Broadband Radio Service (CBRS) band.

<https://www.rcwireless.com/20180730/test-and-measurement/cbrs-ongo-test-labs-tag17>

What is private LTE?

The private LTE market is expected to see significant growth over the next few years, according to a number of analysts' projections. So what is private LTE?

<https://www.rcwireless.com/20180703/fundamentals/what-is-private-lte-tag6-tag99>



To: Laviolette, Joshua (IC)[joshua.laviolette@canada.ca]
From: STS Market Intelligence / SST Connaissance du marche (IC)
Sent: Tue 25/09/2018 6:15:49 PM
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Subject: Market Highlights
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Market Highlights

Date: September 25, 2018

Top Stories

Didn't get the tornado emergency alert? It could be your phone

If you didn't get an emergency alert on your phone Friday, it could be because you have an older phone. Phones, radios and televisions across the National Capital Region emitted an alert tone late Friday afternoon as several tornadoes hit the area, flattening homes and putting lives at risk. Scott Shortliffe, the Canadian Radio-television and Telecommunications Commission's chief consumer officer, said the alerts were designed to work with 4G LTE phones.

<https://www.cbc.ca/news/canada/ottawa/ottawa-tornado-emergency-alert-phone-1.4837185>

ISED launches consultations to review broadcasting, telecom sectors

Innovation, Science and Economic Development Canada's (ISED) Broadcasting and Telecommunications Legislative Review Panel has officially launched its consultation process to review Canada's Telecommunications Act, Radiocommunication Act and Broadcasting Act.

<https://mobilesyrup.com/2018/09/25/ised-launches-consultations-review-broadcasting-telecom-sectors/>

Rogers Communications partners with the University of British Columbia (UBC) to build 5G Hub in Vancouver

Rogers aims to start deploying 5G-ready network equipment and infrastructure at UBC starting in early 2019.

<https://www.rcrwireless.com/20180921/carriers/rogers-communications-partners-ubc-build-5g-hub-vancouver>

Ottawa touts private, public test sites and diverse weather in bid for Autonomous Vehicle (AV) research

In promoting itself as a global centre for autonomous vehicle testing, the City of Ottawa believes it has two can't-miss attractions. The first advantage is a pair of road courses. One of them is private, for refining and ensuring the safety of new technology. The other is public for evaluating that technology in real-world traffic.

<http://canada.autonews.com/article/20180919/CANADA/180919706/1128>

New and Interesting on the Canadian Market

Sierra Wireless Gets Internet of Things (IoT) Module Certified

Sierra Wireless, a Canadian company headquartered in BC, recently received Canadian certification for a Wi-Fi and Bluetooth combo module designed for IoT applications.

<https://www.sierrawireless.com/products-and-solutions/embedded-solutions/products/bx3100/>

Medication Delivery System Component Receives Canadian Certification

AceAge Inc., a Canadian company from Ontario, has recently received Canadian certification for a component of their medication delivery system called Karie.

<http://kariehealth.com/>

5G

Is 5G just a testbed for 6G? (is 5G the new 3G?)

"5G will do the boring stuff first". The low-latency pyrotechnics that will fire the industrial sector into a new gear for the first time will come much later. The version of 5G that radio engineers are preparing and network marketers are promoting is only a quick-step from 4G. It won't change anything.

<https://enterpriseiotinsights.com/20180920/internet-of-things/5g-testbed-for-6g>

UK's Vodafone announces 2019 5G commercial launch and 1,000 sites by 2020

Vodafone has confirmed it will be ready to hit the 5G on-switch as soon as devices are available on the market, though only in Manchester in the first instance.

<http://telecoms.com/492316/vodafone-announces-2019-commercial-launch-and-1k-5g-sites-by-2020/>

Samsung to provide 5G solutions for SK Telecom

Korean telecom operator SK Telecom has selected compatriot company Samsung Electronics for the provision of 5G solutions, including a 3GPP Release 15-compliant core and Radio Access Network for 5G New Radio.

<https://www.rcrwireless.com/20180918/5g/samsung-provide-5g-solutions-sk-telecom>

AT&T opens Texas innovation lab for industry 'verticals' to test 5G, Artificial Intelligence (AI), Software Defined Networking (SDN) and Internet of Things (IoT)

AT&T is inviting companies in the manufacturing, retail, health, finance, and public sector industries into its Foundry innovation lab in Plano, Texas, for the first time to collaborate on new digital solutions.

<https://enterpriseiotinsights.com/20180921/channels/news/att-opens-innovation-lab-to-industry>

UK's Vodafone demonstrates 5G support for holographic calling

While 5G hasn't been deployed at enough scale for the first killer app to emerge, the next generation of cellular will sport major capacity increases and latency decreases. In the U.K., operator Vodafone this week conducted a 5G demonstration of holographic calling.

<https://www.rcrwireless.com/20180920/5g/vodafone-5g-holographic-calling>

Artificial Intelligence (AI)

Report finds Canadian firms fall behind in adoption of artificial intelligence

A new report says artificial intelligence deployment has not yet been a "real success" for Canadian companies, in spite of the country's reputation as an AI hotbed.

<https://globalnews.ca/news/4481530/artificial-intelligence-adoption-canadian-firms/>

Global Artificial Intelligence in Transportation Market 2018 to Witness a Commendable CAGR 17.86% by 2023

International Artificial Intelligence in Transportation market is anticipated to reach USD 1.19 Billion by 2023 by USD 10.05 Billion in 2017, growing at a CAGR of 17.86% from 2018 to 2023.

<https://amazingnewshub.com/global-artificial-intelligence-in-transportation-market-2018-to-witness-a-commendable-cagr-17-86-by-2023/11390/>

Cybersecurity

New cybersecurity chief defends Canadian approach to Huawei security rumours

The head-designate of the newly created Canadian Centre for Cybersecurity told members of the House of Commons Public Safety and National Security committee (SECU) that a holistic approach is necessary to defend the country's digital infrastructure.

<https://mobilesyrup.com/2018/09/24/huawei-security-rumours-new-cybersecurity-chief-defends-approach/>

RCMP's ability to police digital realm 'rapidly declining,' commissioner warned

Organized crime is moving online and the Royal Canadian Mounted Police is struggling to keep up, according to a briefing note prepared for RCMP Commissioner Brenda Lucki when she took over the top job earlier this year.

<https://www.cbc.ca/news/politics/lucki-briefing-binde-cybercrime-1.4831340>

UK's Information Commissioner's Office (ICO) issues its first General Data Protection Regulation (GDPR) fine

AggregatIQ, the Canadian company that has been linked to data firm Cambridge Analytica, is the target of the first GDPR fine to be handed out by the Information Commissioner's Office.

<https://www.v3.co.uk/v3-uk/news/3063194/ico-issues-its-first-gdpr-fine>

Public Safety

US Nationwide Emergency Alerting Test Postponed Until Oct. 3.

The Federal Emergency Management Agency (FEMA), in coordination with the Federal Communications Commission (FCC), postponed a nationwide test of the emergency alert system (EAS) and wireless emergency alerts (WEA) until Oct. 3.

<https://www.rmediagroup.com/News/NewsDetails/NewsID/17369>

Australian Telecom Telstra Demonstrates Cell Network and Drones for Disaster Recovery

Australian telecommunications company Telstra is trialing new drone technologies that use the pre-existing cellular network and unmanned aerial vehicles to assist authorities in post-natural disaster management, according to a press release.

<http://www.thedrive.com/tech/23729/australian-telecom-telstra-demonstrates-cell-network-and-drones-for-disaster-recovery>

Regulatory

US Regulatory holdups not slowing down CBRS

Conversations and news out of Mobile World Congress Americas last week in Los Angeles served as a reminder that, despite an ongoing lag at the regulatory level, the telecom ecosystem is ready to get to work on commercializing services in the 3.5 GHz Citizens Broadband Radio Service band.

<https://inbuildingtech.com/network-infrastructure/cbrs-regulatory-holdups/>
FCC Warns on Noncompliant VHF/UHF Two-Way Radios

The FCC's Enforcement Bureau released an enforcement advisory, noting that it has observed that an increasing number of conventional retailers and websites that advertise and sell low-cost, two-way VHF/UHF radios that do not comply with the FCC's rules. Many of the radios violate one or more FCC technical requirements, the commission said.

<https://www.rrmediagroup.com/News/NewsDetails/NewsID/17392>
FCC Wireless Siting Reform is Key to U.S. 5G Leadership

The Federal Communications Commission will take a major step toward making the United States ready for 5G. The agency will set national guidelines for states and municipalities regarding wireless infrastructure — guidelines that reflect and are designed to promote the wireless networks of the 21st century.

<https://morningconsult.com/opinions/fcc-wireless-siting-reform-is-key-to-u-s-5g-leadership/>

German politicians slam watchdog's 5G auction rules

German politicians have criticised the country's telco watchdog for not including strict coverage obligations as part of its draft 5G auction rules.

<https://www.totaltele.com/501119/German-politicians-slam-watchdogs-5G->

[auction-rules](#)

Austria's TTK opens applications for 3.4-3.8 GHz band auction

The Austrian Telecom Control Commission (TKK) published tender documentation for the auction of frequencies in the 3.4-3.8 GHz band. The auction is planned for the first quarter of 2019.

<https://www.telecompaper.com/news/austrias-tkk-opens-applications-for-34-38-ghz-band-auction--1261445>

Indian Government may open up new 5G frequency bands after Trai proposal

NEW DELHI: The Department of Telecommunications (DoT) is willing to open up new spectrum bands to facilitate ultra-high-speed fifth-generation or 5G services but only after a formal proposal from the sector regulator, said telecom secretary Aruna Sundararajan.

<https://economictimes.indiatimes.com/industry/telecom/telecom-news/awaiting-trai-proposal-for-new-5g-bands-telecom-secretary/articleshow/65862660.cms>

Hong Kong kicks off spectrum sale, bidding to start in December

Regulator gives incumbents first dibs on some 1800 MHz spectrum, more airwaves to be sold via auction.

<https://www.totaltele.com/501152/Hong-Kong-kicks-off-spectrum-sale-bidding-to-start-in-December>

Satellite

Astrocast on satellite mission to fill in coverage for IoT

Astrocast, a Lausanne, Switzerland-based company, is preparing to launch a constellation of satellites that could be used to "fill in" areas that cellular IoT technologies don't cover.

<https://www.fiercewireless.com/wireless/astrocast-satellite-mission-to-fill-coverage-for-iot>

Smart Cities

The benefits of edge computing, IoT for mobile operators in the smart city space

Mobility has paved the way for the rapid adoption of the Internet of Things (IoT) and connected devices worldwide. At the core of IoT and edge computing technologies is mobile networking, which has given rise to Big data, analytics,

and cloud computing taking over what was once on-premise and dumb enterprise systems and networks, ranging from security solutions to customer assistance platforms.

<http://telecoms.com/opinion/the-benefits-of-edge-computing-iot-for-mobile-operators-in-the-smart-city-space/>

ABI Sees Wireless Carrier Smart City Opportunity of \$7.6 Billion by 2023

A new report from ABI Research says that Mobile Service Providers (MSPs) can use their strength and expertise to gain significant indirect and direct revenues from the smart city between now and 2023.

<https://www.telecompetitor.com/abi-sees-wireless-carrier-smart-city-opportunity-of-7-6-billion-by-2023/>

Smart Transportation

BlackBerry and L-Spark announce new accelerator program for startups

BlackBerry has a long history of working with various organizations to help drive technology advancements. Their latest partnership announced earlier today is with L-Spark and will see BlackBerry help medium-sized technology enterprises grow their businesses using BlackBerry QNX technology.

<https://crackberry.com/blackberry-and-l-spark-announce-new-accelerator-program-startups>

Alberta village could be 'Foremost' destination for UAS technology

The Government of Canada's investment in the Foremost UAS Range represents an opportunity for Alberta to become a leader of BVLOS technologies and applications.

<https://www.verticalmag.com/press-releases/alberta-village-could-be-foremost-destination-for-uas-technology/>

Florida town to test world's first driverless school shuttle

The yellow shuttle will transport up to 12 children and will operate from a designated pick-up spot on a pre-set route with a safety attendant on board.

<https://www.smartcitiesdive.com/news/Babcock-Ranch-florida-test-world-first-driverless-school-shuttle/532802/>

Daimler, Bosch complete automated valet parking pilot in China

German companies Daimler and Bosch have announced the completion of a joint, automated valet parking pilot in China's capital Beijing.

<https://enterpriseiotinsights.com/20180918/connected-cars-2/daimler-bosch-complete-automated-valet-parking-pilot-china>

Smart Wearables

Privacy experts say choosing life insurance tied to fitness tracking could have unintended consequences

Privacy experts say they're concerned life-insurance programs that reward customers for behaviours like logging their activity using a fitness tracker could have unintended consequences for the safety of their personal data.

<https://www.cbc.ca/news/business/privacy-life-insurance-john-hancock-1.4833193>

Telecom

US outdoor small cell antenna shipments to grow by 75% in 2018: Study

U.S. outdoor small cell antenna shipments are forecasted to increase by 75% in 2018 compared to the previous year, due to increasing demand from all four U.S. national mobile operators as well as neutral host operators, according to the latest report from E.J.L. Wireless Research.

<https://www.rcwireless.com/20180921/network-infrastructure/us-outdoor-small-cell-antenna-shipments-grow-77-2018-study>

Here are the Google Pixel 3, Galaxy S10 and Huawei Mate 20 Pro leaks from last week

Here's a breakdown of almost every smartphone leak from the last few days. The information below encompasses news from September 15th to September 21st.

<https://mobilesyrup.com/2018/09/22/google-pixel-3-samsung-galaxy-s10-mate-20-pro-leaks/>



To: Salas, Tania (IC)[tania.salas@canada.ca]
From: STS Market Intelligence / SST Connaissance du marche (IC)
Sent: Wed 10/10/2018 1:49:37 PM
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Market Highlights

Date: October 10, 2018

Top Stories

Canadian Government IT Security Boss on Huawei: 5G Review Isn't Over Yet

Reading one of Canada's biggest newspapers, you might get the impression our electronic spy agency doesn't see a need to forbid this country's telecom carriers from buying equipment from China's Huawei Technologies for their next-generation 5G cellular networks.

<https://www.itworldcanada.com/article/canadian-government-it-security-boss-on-huawei-5g-review-isnt-over-yet/409807>

The Canadian Radio-Television and Telecommunications Commission (CRTC) Should Have Oversight Over Utility Poles: Telecoms

Rogers Communications Inc. and Shaw Communications Inc. are both asking the federal government to make it easier for telecoms to access infrastructure such as roads and utility poles as they deploy 5G networks.

<https://thewirereport.ca/2018/10/03/crtc-should-have-oversight-over-utility-poles-telecoms/>

Freedom Mobile Begins Deploying 700MHz Spectrum in Calgary

Shaw Communications-owned regional carrier Freedom Mobile has officially begun rolling out its Band 13 700MHz spectrum to subscribers in Calgary.

<https://mobilesyrup.com/2018/10/09/freedom-mobile-calgary-alberta-700-mhz-spectrum-deployment/>

New and Interesting on the Canadian Market

ASUS Receives Canadian Certification for 802.11ax Router

Asian manufacturer ASUS recently received Canadian certification for an 802.11ax gaming router. The router uses the relatively new 802.11ax standard which allows for higher throughput and greater capacity for multiple connections.

<https://rog.asus.com/articles/networking/rog-rapture-gt-ax11000-tri-band-802-11ax-router/>

5G

Mobile Operator EE Switches On its First 5G Live Trial Site in the UK

EE has switched on the UK's first live 5G trial site at London's Canary Wharf centre. The live trial will take place in Montgomery Square, Canary Wharf – an area that receives 150,000 visitors and commuters every day.

<https://www.totaltele.com/501255/EE-switches-on-its-first-5G-live-trial-site-in-the-UK>

Indian Government Invites Huawei to Take Part in 5G Trials

Chinese vendor Huawei said it has received an invitation from the Indian government to take part in the country's 5G trials, Indian press reported.

<https://www.rcrwireless.com/20181008/5g/indian-government-invites-huawei-take-part-5g-trials-report>

Qualcomm to Demo 5G on 3.5GHz at Consumer Electronics Show (CES)

Qualcomm is applying to demonstrate 5G equipment, using 3.5GHz frequencies, at the Consumer Electronics Show in Las Vegas early January.

<https://www.lightreading.com/mobile/5g/qualcomm-to-demo-5g-on-35ghz-at-ces/d/d-id/746628>

Deutsche Telekom, Telefonica Deutschland Ink Backhaul Deal Ahead of 5G

German carriers Deutsche Telekom and Telefónica Deutschland have announced an agreement to speed up the deployment of 5G networks and reduce cost.

<https://www.rcrwireless.com/20181008/5g/deutsche-telekom-telefonica-deutschland-ink-deal-ahead-5g>

Ranplan Releases the World's First Heterogeneous Wireless Planning Tool Supporting 5G

Ranplan Wireless, provider of the industry's only in-building and outdoor wireless planning and optimisation software solution, has announced the release of Ranplan Professional 5.2, offering key functionality to support 5G New Radio (NR).

<https://www.realwire.com/releases/Ranplan-releases-the-worlds-first-heterogeneous-wireless-planning-tool>

Artificial Intelligence (AI)

IBM Mixes AI and IoT in Bespoke Apps for Farming, Manufacturing, Logistics

IBM has released a range of new Watson artificial intelligence (AI) solutions and services tailored for the agriculture, manufacturing, supply chain, building management, and automotive industries.

<https://enterpriseiotinsights.com/20181004/channels/news/ibm-mixes-ai-and-iot-for-verticals>

Blockchain

UK Telecom Regulator Wins Grant to Study Blockchain

The Regulators' Pioneer Fund announced on Friday that it would award nearly £700,000 (just under \$915,000) to Ofcom, the national telecommunications regulatory authority, "for a project that uses blockchain technology to improve U.K. telephone number management."

<https://www.coindesk.com/uk-telecom-regulator-wins-grant-to-study-blockchain/>

Cybersecurity

Canadian Companies Are Overconfident When it Comes to Cyberattacks, Study Finds

Canadian companies tend to be overconfident or unprepared to protect sensitive information from data breaches — mostly because they have an incomplete or inadequate picture about the evolving challenges they face, according to cybersecurity experts.

<https://www.cbc.ca/news/business/canadian-companies-overconfident-cybersecurity-1.4850989>

Google Did not Disclose Security Bug Because it Feared Regulation

Google did not initially disclose a Google+ security bug when it first discovered it this spring because it feared regulatory scrutiny and reputational damage.

<https://www.cnbc.com/2018/10/08/google-reportedly-exposed-private-data-of-at-least-hundreds-of-thousands-of-plus-users.html>

Los Angeles to Expand Cybersecurity Lab

Bolstered by a \$3 million grant from the U.S. Department of Homeland Security, the City of Los Angeles will expand the capabilities of a public-private partnership to protect the city against hacker attacks and support the cybersecurity industry.

<https://www.smartcitiesdive.com/news/los-angeles-to-expand-cybersecurity-lab/539170/>

Irish Data Regulator Seeks Information from Google on Security Bug

Ireland's data protection regulator said on Tuesday that it would seek more information from Alphabet Inc's Google regarding a security issue that may have exposed the data of at least 500,000 users to hundreds of external developers.

<https://www.reuters.com/article/google-data-irish-regulators/irish-data-regulator-seeks-information-from-google-on-security-bug-idUSL4N1WP3QZ>

Internet of Things (IoT)

The Key Role of Antenna Optimization in IoT Devices

As the Machine-to-machine M2M has evolved into the internet of things, the rapidly growing market is driving transformation and creating value in virtually every segment of the consumer, enterprise and industrial markets.

<https://www.rcwireless.com/20181003/sponsored/the-key-role-of-antenna-optimization-in-iot-devices>

Regulatory

Federal Communications Commission's (FCC's) 3.5 GHz CBRS Proposal Sparks Cheers, Fears

As expected, the FCC's latest plan for the 3.5 GHz Citizens Broadband Radio Service (CBRS) band isn't going to please everyone, but FCC Commissioner Michael O'Rielly says it achieves a sound and just result.

<https://www.fiercewireless.com/wireless/fcc-s-3-5-ghz-cbrs-proposal-sparks-cheers-fears>

Second Disappointment for Thai 900MHz Auction

Thailand's upcoming 900MHz spectrum auction could be delayed by the non-participation of two leading operators.

<https://www.developingtelecoms.com/telecom-technology/wireless-networks/8087-second-disappointment-for-thai-900mhz-auction.html>

Satellite

Telesat, Newtec Put LEO Satellite to the Test

Telesat's Phase 1 LEO satellite was launched on January 12, 2018, and the company is now conducting live demonstrations of its capabilities – an important milestone in Telesat's plans to deploy a global LEO constellation that will revolutionize broadband communications around the world.

<https://www.lightreading.com/gigabit/wireless-satellite/telesat-newtec-put-leo-satellite-to-the-test-/d/d-id/746647>

Satellite Project Anticipates Affordable Broadband for Africa

Johannesburg — LOCALLY developed satellite technology is anticipated to lower the cost of broadband access endured by most Africans and enable them reap the benefits of inclusive, affordable and reliable internet services.

<https://allafrica.com/stories/201810090730.html>

Smart Cities

Harnessing the Power of Video to Create Smart Cities

Technologies like AI and machine learning may one day make cities smarter, but in the mean time municipalities should focus on proven, mature tech solutions, such as video surveillance systems.

<https://www.smartcitiesdive.com/news/harnessing-the-power-of-video-to-create-smart-cities/539209/>

Smart Transportation

Honda Commits \$2.75 Billion to Build Autonomous Vehicles With GM's Cruise

Honda will commit \$2.75 billion as part of an exclusive agreement with GM and its self-driving technology subsidiary Cruise to develop and produce a new kind of autonomous vehicle.

<https://techcrunch.com/2018/10/03/honda-commits-2-75-billion-in-partnership-with-gms-cruise/>

Telecom

Device Ecosystem Challenge Makes 4.5G Roadmap Foggy

NEW DELHI: Telecom service providers next-generation leap has an apparent challenge staring at 4.5G technology-powered device ecosystem with low-to-mid tier smartphones lacking support for the newer technology.

<https://telecom.economictimes.indiatimes.com/news/device-ecosystem-challenge-makes-4-5g-roadmap-foggy/66114974>

Ottawa May be Eyeing New Rules to Protect Bank, Telecom Consumers

Prime Minister Trudeau asked seniors' minister Filomena Tassi to help Finance Minister Bill Morneau, and Minister of Innovation, Science and Economic Development Navdeep Bains on the design and implementation of initiatives to better protect consumers, particularly seniors, from high-pressure sales tactics, overbilling, fraud and other potential harms.

<https://business.financialpost.com/news/fp-street/ottawa-may-be-eyeing-new-rules-to-protect-bank-telecom-consumers>



Cleary, Cheryl (IC)

From: Hussein, Muna (IC)
Sent: September 7, 2018 3:39 PM
To: Hsiung, Peter (IC); Siddiqui, Kulsum (IC)
Cc: Je, Paul (IC)
Subject: FW: [redacted] 20(1)(b)
Attachments: [redacted] 20(1)(b)

FYA please.
Thank you.

From: Paul Goodrick [redacted] 19(1) [redacted]@rci.rogers.com]
Sent: September-07-18 3:38 PM
To: Hussein, Muna (IC)
Subject: [redacted] 20(1)(b)

Hello Muna,

Rogers is looking to conduct [redacted] 20(1)(b) [redacted] 20(1)(b)
[redacted] 20(1)(b)

All the details and formal request are in the attached letter. Please let me know if you require any further information to process this request. Also, let me know if I should continue to work [redacted] 19(1) on this request.

Thanks,
Paul

Paul Goodrick
Sr. Manager, Spectrum Policy

Rogers Communications
350 Bloor Street East, 6th Floor
Toronto, ON M4W 0A1

[redacted] 19(1) [redacted]@rci.rogers.com
o 416.935.8974 m [redacted] 19(1)
f 416.935.7719



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Cleary, Cheryl (IC)

From: Chuang, Angela (IC)
Sent: September 18, 2018 7:09 PM
To: Hsiung, Peter (IC)
Cc: Mendes, Fernando (IC)
Subject: FW: Rogers [redacted] 20(1)(b)
Attachments: [redacted] 20(1)(b)

Hi Peter,

Given there could be earlier discussion for their proposal in Ontario [redacted] 21(1)(a)
just to double-check: might there be any other background I should account/watch for?

[redacted] 21(1)(a)

Thanks,
Angela

From: Paul Goodrick [redacted] 19(1) [redacted]@rci.rogers.com]
Sent: September-18-18 1:13 PM
To: Chuang, Angela (IC)
Subject: Rogers [redacted] 20(1)(b)

Hi Angela,

I'm with Rogers' regulatory team, supporting [redacted] 20(1)(b)
[redacted] 20(1)(b) we
wanted to provide some advanced notice to the Western office to assist with planning.

[redacted] 20(1)(b)

[redacted] 20(1)(b)

[redacted] 20(1)(b)

I look forward to working with you [redacted] 20(1)(b) Let me know if you have any further questions for me at this time.

Thanks,
Paul

Paul Goodrick
Sr. Manager, Spectrum Policy

Rogers Communications
350 Bloor Street East, 6th Floor
Toronto, ON M4W 0A1

19(1) @rci.rogers.com
o 416.935.8974 m 19(1)
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Cleary, Cheryl (IC)

From: Hussein, Muna (IC)
Sent: November 8, 2018 4:24 PM
To: Je, Paul (IC)
Cc: Hsiung, Peter (IC)
Subject: FW: [redacted] 20(1)(b)
Attachments: [redacted] 20(1)(b)
Sensitivity: Confidential

FYI

From: Paul Goodrick [redacted] 19(1) [redacted]@rci.rogers.com]
Sent: November-08-18 3:01 PM
To: Hussein, Muna (IC)
Subject: [redacted] 20(1)(b)
Sensitivity: Confidential

Muna,

As previously discussed, Rogers is providing the [redacted] 20(1)(b)
[redacted] 20(1)(b)

We are currently targeting [redacted] 20(1)(b) These dates are to be confirmed and we may be bringing them forward. Also, while [redacted] 20(1)(b) [redacted] 20(1)(b) Before deploying, I will advise on any changes [redacted] 20(1)(b)

[redacted] 20(1)(b)

Please let me know if you require any further information at this time. [redacted] 20(1)(b)
[redacted] 20(1)(b)

Thanks,
Paul

Paul Goodrick
Sr. Manager, Spectrum Policy

Rogers Communications
350 Bloor Street East, 6th Floor
Toronto, ON M4W 0A1

[redacted] 19(1) [redacted]@rci.rogers.com
o 416.935.8974 [redacted] 19(1)
f 416.935.7719



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Meeting with ISED 21(1)(a),21(1)(b) M-MIMO

November 29, 2018 12:30-2:30pm

Attendees:

ISED: Greguy Saint-Pierre, Marc Corbin, Josette Gallant, Paul Ma, Ron Flieler, Eric Parsons, Hughes Nappert, Matthew Messer, Joel Olenga, Jacob Morris, Abrar Fuad,

19(1),21(1)(b)

Rogers: 19(1)

* Attended remotely

Summary of Meeting:

- Massive MIMO (M-MIMO) will be a very important new antenna technology in 5G deployment.

21(1)(a)

- Theoretical models used by 21(1)(a),21(1)(b) demonstrate that "actual maximum" power for M-MIMO is below 25% of maximum for 95% of the time. It was suggested 21(1)(a),21(1)(b)

21(1)(a),21(1)(b)

- 21(1)(a),21(1)(b)
- 21(1)(a),21(1)(b)

- ISED noted that IEC Technical Report 62669 Ed.2 containing case studies has been drafted and will be sent for voting soon so it is not finalized yet. IEC 62232 Edition 3 international standard will not be finalized until December 2020.

21(1)(a),21(1)(b)

- Chair of the 21(1)(a),21(1)(b) and will see if carriers can meet to discuss the work being done within the IEC TC106 and also in

21(1)(a),21(1)(b)

- ISED encourages Canadian carrier representation at International EMF Standards meetings. 21(1)(a),21(1)(b) indicated initial interest.

21(1)(a),21(1)(b)

- [Redacted]
- [Redacted]

Action Items:

- ISED to see if it can share investigative data [Redacted]
- [Redacted]
- Carriers should determine if they will participate in domestic and international IEC standards meetings. [Redacted]
- [Redacted]

Macdonald, Suzanne (IC)

From: Macdonald, Suzanne (IC)
Sent: January 18, 2019 5:10 PM
To: Wong, Tony (IC); Saint-Pierre, Greguy (IC); Corbin, Marc (IC)
Cc: Nappert, Hughes (IC); Gallant, Josette (IC); Morris2, Jacob (IC); Sohi, Sarv (IC); Chuang, Angela (IC); Mohabeer, Sumesh (IC); Lai, Vicky (IC); Beik, Elias (IC); Paul, Eddy (IC); Flieler, Ron (IC); Liu, Herrick (IC)
Subject: RE: Official correspondence [redacted] compliance of developmental 5G licences

Hi Tony,

In response to your request for an official response letter, please see the text below....

Texte français suit l'anglais

As a condition of authorization, all antenna installations must comply with the uncontrolled environment limits of [redacted] 21(1)(a), 21(1)(b) at all times. Site compliance is based on the radio frequency (RF) emissions present at the entire site, including the combined effects of nearby antenna installations within the local radio environment, not only the operator's own installation. The above requirement applies to all antenna installations, including those related to '5G' and Massive MIMO (M-MIMO), whether installed for developmental purposes or otherwise.

As captured in the summary of the November 29, 2018 meeting between ISED and members of the telecommunications industry, [redacted] 21(1)(b) ISED indicated that a conservative approach to compliance for M-MIMO must be taken. This approach requires that 100% power output for antenna installations at the site be used in determining [redacted] 21(1)(a), 21(1)(b) compliance. As part of the discussion, in order to aid in further assessment of M-MIMO installations, ISED requested carriers provide calculations/simulations utilizing 100% power output, 25% power output and actual measurements for these installations. Assessment of the above information as well as any other relevant research will continue in order to further the goal of expediting implementation of this technology.

Should you have any questions regarding this matter please do not hesitate to contact me.

Sincerely,

À titre de condition d'autorisation, toutes les installations d'antennes doivent se conformer en tout temps aux limites du [redacted] 21(1)(a), 21(1)(b) pour les environnements non contrôlés. La conformité du site est fondée sur les émissions de radiofréquences (RF) présentes sur l'ensemble du site, y compris les effets combinés d'antennes à proximité de l'installation dans l'environnement radio local et non seulement l'installation de l'exploitant. L'exigence ci-dessus s'applique à toutes les installations d'antennes, y compris celles liées aux '5G' et utilisant une technique d'entrées multiples – sorties multiples massives (EMSM-M), installées à des fins de développement ou autre.

Tel qu'indiqué dans le résumé de la rencontre du 29 novembre 2018 entre ISDE et les membres de l'industrie des télécommunications, qui comprenait [redacted] 21(1)(b) ISDE indique qu'une approche prudente de conformité pour EMSM-M doit être prise. Cette approche exige que 100 % de la puissance de sortie pour les installations d'antennes sur le site soit utilisé afin de déterminer la conformité au [redacted] 21(1)(a), 21(1)(b). Dans le cadre de la discussion, afin d'aider à une évaluation plus poussée des installations EMSM-M, ISDE a demandé aux compagnies de fournir des

calculs et des simulations utilisant une puissance de sortie de 100 %, de 25 % de la puissance de sortie et des mesures réelles pour ces installations. L'évaluation de l'information ci-dessus ainsi que de tout autre résultat de recherche pertinente continuera afin de poursuivre l'objectif d'accélérer la mise en œuvre de cette technologie.

Si vous avez des questions à ce sujet, n'hésitez pas à communiquer avec moi.

Cordialement,

Have a great weekend.

Suzanne Macdonald

Manager, Operational Policies, Spectrum Management Operations Branch
Innovation, Science and Economic Development Canada / Government of Canada
Suzanne.Macdonald@Canada.ca / Tel: 613-608-1645 / TTY: 1-866-694-8389

Gestionnaire, Politiques opérationnelles, Direction générale des opérations de la gestion du spectre
Innovation, Sciences et Développement économique Canada / Gouvernement du Canada
Suzanne.Macdonald@Canada.ca / Tel: 613-608-1645 / TTY: 1-866-694-8389

From: Wong, Tony (IC) <tony.wong@canada.ca>
Sent: January 16, 2019 5:35 PM
To: Saint-Pierre, Greguy (IC) <greguy.saint-pierre@canada.ca>; Corbin, Marc (IC) <marc.corbin@canada.ca>; Macdonald, Suzanne (IC) <suzanne.macdonald@canada.ca>
Cc: Nappert, Hughes (IC) <hughes.nappert@canada.ca>; Gallant, Josette (IC) <josette.gallant@canada.ca>; Morris2, Jacob (IC) <jacob.morris2@canada.ca>; Sohi, Sarv (IC) <sarv.sohi@canada.ca>; Chuang, Angela (IC) <angela.chuang@canada.ca>; Mohabeer, Sumesh (IC) <sumesh.mohabeer@canada.ca>; Lai, Vicky (IC) <vicky.lai@canada.ca>; Beik, Elias (IC) <elias.beik@canada.ca>; Paul, Eddy (IC) <eddy.paul@canada.ca>; Flieler, Ron (IC) <ron.flieler@canada.ca>; Liu, Herrick (IC) <herrick.liu@canada.ca>
Subject: RE: Official correspondence (b) (1), (b) (2) (i) compliance of developmental 5G licences

Hi Suzanne / Marc,

Would we be able to get an official response letter reiterating that ISED requires (b) (1), (b) (2) (i) theoretical analysis using 100% power level as discussed during the ISED / carriers meeting Nov. 29, 2018. I anticipate all regions will start receiving 5G developmental applications using massive MIMO and would like us to have the exact same messaging.

Regards,
Tony Wong
306-221-1875

From: Saint-Pierre, Greguy (IC)
Sent: January-16-19 3:12 PM
To: Wong, Tony (IC); Corbin, Marc (IC); Macdonald, Suzanne (IC)
Cc: Nappert, Hughes (IC); Gallant, Josette (IC); Morris2, Jacob (IC); Sohi, Sarv (IC); Chuang, Angela (IC); Mohabeer, Sumesh (IC); Lai, Vicky (IC); Beik, Elias (IC); Paul, Eddy (IC); Flieler, Ron (IC); Liu, Herrick (IC)
Subject: RE: Official correspondence (b) (1), (b) (2) (i) compliance of developmental 5G licences

Greetings!

Thank you for this email Tony.

I have to admit that I am a bit surprised by what is written in this email [redacted] 21(1)(b)
[redacted] 21(1)(b) For convenience, I've attached a copy of the meeting's
summary and highlighted where we've agreed that service providers were to perform their assessment using 100%
power level for M-MIMO [redacted] 21(1)(b) compliance.

As there hasn't been any changes to our approach, we should reiterate the message to our service providers. I wonder if
Marc/Suzanne may be able to help in that regard and ensure we remain consistent nationally.

Best,

Gréguy

From: Wong, Tony (IC)
Sent: January-14-19 5:33 PM
To: Saint-Pierre, Greguy (IC); Mohabeer, Sumesh (IC); Lai, Vicky (IC); Beik, Elias (IC); Paul, Eddy (IC); Flieler, Ron (IC);
Liu, Herrick (IC)
Cc: Nappert, Hughes (IC); Gallant, Josette (IC); Morris2, Jacob (IC); Sohi, Sarv (IC); Chuang, Angela (IC)
Subject: RE: Official correspondence [redacted] 21(1)(b) compliance of developmental 5G licences

Hi Greguy,

[redacted] 20(1)(b).21(1)(b)

[redacted] 20(1)(b).21(1)(b)

20(1)(b).21(1)(b)

21(1)(b)

20(1)(b).21(1)(b)

What is our stance on 20(1)(b).21(1)(b) compliance with 5G massive MIMO? I just want to make sure we are all doing the same thing nationally.

Regards,
Tony Wong
306-221-1875

From: Saint-Pierre, Greguy (IC)
Sent: December-17-18 11:35 AM
To: Wong, Tony (IC); Mohabeer, Sumesh (IC); Lai, Vicky (IC); Beik, Elias (IC); Paul, Eddy (IC); Flieler, Ron (IC); Liu, Herrick (IC)
Cc: Nappert, Hughes (IC); Gallant, Josette (IC); Morris2, Jacob (IC)
Subject: RE: Official correspondence [redacted] compliance of developmental 5G licences

Greetings!

We have to be careful on the terminology here. What is presented may be for 5G readiness, but is it actually 5G?

[redacted] 21(1)(b)
[redacted] 21(1)(b) Therefore, at this point, I see no need to tweak our messaging or stance. However, it is noted that we should come up with a set of requirements of what we'd like to see when dealing with a 5G installation using m-MIMO. I think it may be worthwhile to discuss with the RECWG.

Best,

Gréguy

From: Wong, Tony (IC)
Sent: December-17-18 12:04 PM
To: Saint-Pierre, Greguy (IC); Mohabeer, Sumesh (IC); Lai, Vicky (IC); Beik, Elias (IC); Paul, Eddy (IC); Flieler, Ron (IC); Liu, Herrick (IC)
Cc: Nappert, Hughes (IC); Gallant, Josette (IC)
Subject: RE: Official correspondence [redacted] compliance of developmental 5G licences

Hi Greguy,

[redacted] 21(1)(b)
[redacted] 21(1)(b) We will request proof of compliance from them prior to allowing them to proceed with the developmental licence. I just wanted to make sure that everyone is on the same page when requesting demonstration of compliance for 5G testing.

Regards,
Tony Wong
306-221-1875

From: Saint-Pierre, Greguy (IC)
Sent: December-14-18 3:16 PM
To: Wong, Tony (IC); Mohabeer, Sumesh (IC); Lai, Vicky (IC); Beik, Elias (IC); Paul, Eddy (IC); Flieler, Ron (IC); Liu, Herrick (IC)
Cc: Nappert, Hughes (IC); Gallant, Josette (IC)
Subject: RE: Official correspondence [redacted] compliance of developmental 5G licences

Greetings!

The official stance is the installation shall be compliant at all time.

Note that we will need much more technical information to provide guidance. Do you know if they will use a massive MIMO use antenna?

With the information that was in this short email, I suggest follow the guidance we currently have in GL-01 for measurements and/or ask for simulation results if modelling was used for us to start somewhere.

If a theoretical analysis using a statistical approach to determine the "actual maximum" based on a percentile other than 100%, please let me know.

Best,

Gréguy

From: Wong, Tony (IC)

Sent: December-14-18 9:43 AM

To: Mohabeer, Sumesh (IC); Lai, Vicky (IC); Beik, Elias (IC); Paul, Eddy (IC); Nappert, Hughes (IC); Saint-Pierre, Greguy (IC); Flieler, Ron (IC); Liu, Herrick (IC)

Subject: Official correspondence 21(1)(a).21(1)(b) compliance of developmental 5G licences

Hi all,

What is our official stance on the need for demonstrating SC6 compliance with 5G developmental licences? Do we have any official correspondence?

21(1)(a).21(1)(b)

Tony Wong

Regional Spectrum Engineer (Engineer-In-Training), Spectrum Management Operations Branch
Innovation, Science and Economic Development Canada / Government of Canada
tony.wong@canada.ca / Tel: 306-221-1875 / TTY: 1-866-694-8389

Spectre régional Engineer (ingénieur en formation), Direction générale des opérations de la gestion du spectre
Innovation, Sciences et Développement économique Canada / Gouvernement du Canada
tony.wong@canada.ca / Tél. : 306-221-1875 / ATS : 1-866-694-8389

1. 5G Around the World

Tejas Rao, Managing Director and Global 5G Offering Lead for Accenture's Network Practice

- First commercial launches of 5G to take place in 2019, with large scale commercial deployments by 2020.
- Six key challenges: Spectrum availability, strategic use cases/business development, device innovation, network deployment, platform innovation, operational complexity.
- The U.S. and certain Asian countries currently leading in the race to deploy 5G.
 - U.S.:
 - Focus on network densification (150k to 800k small cell antennas nationally);
 - carriers making large scale investments & mergers (spectrum pooling, infrastructure sharing);
 - Strong regulatory approach (e.g. restrict municipal laws inhibiting a provider's ability to deploy, limit fees that municipalities can charge, limit state or local government fees for infrastructure access to cost recovery, etc.)
 - China:
 - One central organization overseeing tower deployment.
 - South Korea:
 - Three main carriers taking coordinated approach to accelerate deployment – single national network.
 - To deploy with devices in first half of 2019.
 - Japan
 - To deploy 5G in time for 2020 Olympic Games.
 - EU
 - Italy leading EU, spectrum auctions complete.
 - Other leaders are U.K., Nordic countries
 - May be delaying slightly because of significant 4G investments, ROI not complete, watching other countries and progress before making more new investments

2. 5G Canada Update

Bruce Rodin, VP Wireless Networks, Bell

Brian O'Shaughnessy, SVP & CTO, Freedom Mobile

Arnold Abramowitz, VP Access Network Engineering, Rogers

- Higher frequencies equal smaller wave lengths
 - Allows for multiple antennas, beam forming and massive MIMO

- Bell:
 - 5G requires continued evolution of network (speed & performance)
 - Using 3.5 GHz better broadband now & pave way for 5G
 - Only FWA for now
 - Will pivot to 5G and use network slice
 - Mid band ~ 2X speed gain
 - mmWave ~10X speed gain
 - 5G trails
 - Downtown Toronto, Stratford, Kitchener/Waterloo, Orangeville
 - Use cases
 - Advanced smart cities, self-driving cars, Industrial IoT
- Rogers:
 - Current partnership with University of BC to build real-world 5G network
 - Consumers will want the newer features/services, but for the same price
 - Must create and communicate value, consumer will pay more
- Freedom:
 - Much of 4G network was built with 5G in mind, current equipment capable of 5G
- Panels Questions/Other Topics:
 - Is Canada behind?
 - No, mid-2020 when quality, early flagship will be launched
 - Believe Canada in a better position than the U.S.
 - Beware of media headlines/hype:
 - Don't tell the entire story
 - First to 5G should not be the focus – learn from other jurisdictions and develop sound, reliable network. It isn't a race.
 - 4G/LTE to continue to expand for next 18-24 months while 5G is being deployed
 - Transition will be seamless – both are compatible.
 - Service Provider Strategies for 5G:
 - Shaw – create seamless service for end-user
 - Bell – leverage existing service and continue to enhance

3. Getting Ready for 5G: A Network Technology Primer

Larry Murat, VP Networks Product Development Solutions, Ericsson

- Presented deck with simple approach to technical elements of 5G (will email CWTA to obtain a copy).
- Excellent diagrams/discussion on beam forming and MIMO
- 5G supports carrier aggregation and dual connectivity
 - Dual connectivity means LTE + 5G at the same time
- Network flexibility
 - Functionalities are virtual can be at the core or on the node
 - Many things that used to be hardware have been re-created in software

4. 5G and Importance of Spectrum

Dean R. Brenner, SVP Spectrum Strategy and Tech Policy, Qualcomm Inc.

- Access to shared/unlicensed spectrum key for success of 5G; higher bands well suited for sharing.
- 5G to build on spectrum sharing technology being deployed under LTE (LTE-U, LAA), continued enhancement of LTE.
- Over 30 5G-ready handsets set for release in 2019.
 - Some in < 6 GHz, some in mmWave
 - Building in many micro-antennas, phones can function on dozens of frequencies
- Spectrum:
 - FCC:
 - Low-band – 600MHz auction held in Spring 2017
 - Mid-band – 3.4-3.5 GHz, 3.7-4.2 GHz
 - High-band – 12.5 GHz of spectrum already allocated – more to come
 - Europe:
 - Looking to make up for performance on deployment of 4G/LTE; 5G Action Plan
 - Six countries where spectrum for 5G already allocated (3.4-3.8 GHz, 28GHz), 18 more in 2019.
 - Germany exploring Industrial IoT – localized spectrum auction (e.g. limited to stadium, factory, etc.)

5. Small Cell Deployment

Paul Cowling, SVP Legal & Regulatory Affairs, Shaw

Michael Piaskoski, Director of Municipal and Industry Relations, Rogers

Song Nhi Nguyen, Enterprise Architect Infrastructure & Security, City of Montreal

Bryan Tramont, Managing Partner, WBK Law

- Smaller coverage area means greater number of antennas required
- Small cells already being deployed under LTE
- Availability of licensed/unlicensed spectrum, increasing capacity to allow for small cells
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7. Privacy in a 5G & Big Data World

Deborah Evans, CPO, Rogers

Pratricia Kasseim, Counsel, Privacy and Data Management, Osler

Anick Fortin-Cousens, CPO and Data Responsibility Advocate, IBM Canada

- Much discussion of GDPR privacy regime in Europe
- Canada's regime is PIPEDA, has many of same rules as European model but people aren't aware
- Users also have some responsibility to protect data

Nolan, Stephen (IC)

From: Saint-Pierre, Greguy (IC)
Sent: January 25, 2019 2:02 PM
To: Gallant, Josette (IC); Losier, Yan (IC); Abou-Zeid, Alain (IC); Ménard2, François (IC); Morris2, Jacob (IC); Tran, Loan (IC); Popovici, Horia (IC)
Cc: Nappert, Hughes (IC); Nolan, Stephen (IC)
Subject: FW: Summary - 5G Canada Council Event - January 23, 2019

Good day folks,

Wednesday, among other ISED folks, Steven, Hughes and I have attended the CWTA Annual 5G Council.

Please find below an excellent summary that Steven prepared for DGSO.

Best,

Gréguy

P.S.: Thank you again for sharing Steven

From: Nolan, Stephen (IC)
Sent: January-25-19 1:36 PM
To: Saint-Pierre, Greguy (IC)
Subject: FW: Summary - 5G Canada Council Event - January 23, 2019

In case you think any of your DGEPS colleagues might find a summary of the event helpful/interesting please see below. Thanks again for providing your notes, they definitely helped to fill in some of the blanks.

Have a great weekend.

Steve

From: Nolan, Stephen (IC) <stephen.nolan@canada.ca>
Sent: January 25, 2019 1:32 PM
Subject: Summary - 5G Canada Council Event - January 23, 2019

Good afternoon everyone,

This past Wednesday, January 23, members of DOS attended the CWTA's Annual 5G Canada Council event here in Ottawa. In the context of the upcoming launch of 5th generation wireless networks some of the main themes from the event included updates on the current situation internationally as well as in Canada, the importance of spectrum, small cell deployment, security and privacy. For those who might be interested below I have provided a detailed summary of the presentations/panels from the event.

If you have any questions or would like to discuss in more detail, please feel free to send me an email or come by my office.

Have a great weekend!

Steve

"DGSO-DOS - Summary of 5G Canada Council (CWTA) - 2019-01-23 - EN.docx" can be accessed via the following link:

16(2)(c)

SUMMARY OF 5G CANADA COUNCIL – JANUARY 23, 2019

1. 5G Around the World

Tejas Rao, Managing Director and Global 5G Offering Lead for Accenture's Network Practice

- First commercial launches of 5G to take place in 2019, with large scale commercial deployments by 2020.
- Six key challenges: Spectrum availability, strategic use cases/business development, device innovation, network deployment, platform innovation, operational complexity.
- The U.S. and certain Asian countries currently leading in the race to deploy 5G.
 - U.S.:
 - Focus on network densification (150k to 800k small cell antennas nationally);
 - carriers making large scale investments & mergers (spectrum pooling, infrastructure sharing);
 - Strong regulatory approach (e.g. restrict municipal laws inhibiting a provider's ability to deploy, limit fees that municipalities can charge, limit state or local government fees for infrastructure access to cost recovery, etc.)
 - China:
 - One central organization overseeing tower deployment.
 - South Korea:
 - Three main carriers taking coordinated approach to accelerate deployment – single national network.
 - To deploy with devices in first half of 2019.
 - Japan
 - To deploy 5G in time for 2020 Olympic Games.
 - EU
 - Italy leading EU, spectrum auctions complete.
 - Other leaders are U.K., Nordic countries
 - May be delaying slightly because of significant 4G investments, ROI not complete, watching other countries and progress before making more new investments

2. 5G Canada Update

Bruce Rodin, VP Wireless Networks, Bell

Brian O'Shaughnessy, SVP & CTO, Freedom Mobile

Arnold Abramowitz, VP Access Network Engineering, Rogers

- Higher frequencies equal smaller wave lengths
 - Allows for multiple antennas, beam forming and massive MIMO
- Bell:
 - 5G requires continued evolution of network (speed & performance)
 - Using 3.5 GHz better broadband now & pave way for 5G

- Only FWA for now
 - Will pivot to 5G and use network slice
 - Mid band ~ 2X speed gain
 - mmWave ~10X speed gain
- 5G trails
 - Downtown Toronto, Stratford, Kitchener/Waterloo, Orangeville
- Use cases
 - Advanced smart cities, self-driving cars, Industrial IoT
- Rogers:
 - Current partnership with University of BC to build real-world 5G network
 - Consumers will want the newer features/services, but for the same price
 - Must create and communicate value, consumer will pay more
- Freedom:
 - Much of 4G network was built with 5G in mind, current equipment capable of 5G
- Panels Questions/Other Topics:
 - Is Canada behind?
 - No, mid-2020 when quality, early flagship will be launched
 - Believe Canada in a better position than the U.S.
 - Beware of media headlines/hype:
 - Don't tell the entire story
 - First to 5G should not be the focus – learn from other jurisdictions and develop sound, reliable network. It isn't a race.
 - 4G/LTE to continue to expand for next 18-24 months while 5G is being deployed
 - Transition will be seamless – both are compatible.
 - Service Provider Strategies for 5G:
 - Shaw – create seamless service for end-user
 - Bell – leverage existing service and continue to enhance

3. Getting Ready for 5G: A Network Technology Primer

Larry Murat, VP Networks Product Development Solutions, Ericsson

- Presented deck with simple approach to technical elements of 5G (will email CWTA to obtain a copy).
- Excellent diagrams/discussion on beam forming and MIMO
- 5G supports carrier aggregation and dual connectivity
 - Dual connectivity means LTE + 5G at the same time
- Network flexibility
 - Functionalities are virtual can be at the core or on the node
 - Many things that used to be hardware have been re-created in software

4. 5G and Importance of Spectrum

Dean R. Brenner, SVP Spectrum Strategy and Tech Policy, Qualcomm Inc.

- Access to shared/unlicensed spectrum key for success of 5G; higher bands well suited for sharing.
- 5G to build on spectrum sharing technology being deployed under LTE (LTE-U, LAA), continued enhancement of LTE.
- Over 30 5G-ready handsets set for release in 2019.
 - Some in < 6 GHz, some in mmWave
 - Building in many micro-antennas, phones can function on dozens of frequencies

- Spectrum:
 - FCC:
 - Low-band – 600MHz auction held in Spring 2017
 - Mid-band – 3.4-3.5 GHz, 3.7-4.2 GHz
 - High-band – 12.5 GHz of spectrum already allocated – more to come
 - Europe:
 - Looking to make up for performance on deployment of 4G/LTE; 5G Action Plan
 - Six countries where spectrum for 5G already allocated (3.4-3.8 GHz, 28GHz), 18 more in 2019.
 - Germany exploring Industrial IoT – localized spectrum auction (e.g. limited to stadium, factory, etc.)

5. Small Cell Deployment

Paul Cowling, SVP Legal & Regulatory Affairs, Shaw

Michael Piaskoski, Director of Municipal and Industry Relations, Rogers

Song Nhi Nguyen, Enterprise Architect Infrastructure & Security, City of Montreal

Bryan Tramont, Managing Partner, WBK Law

- Smaller coverage area means greater number of antennas required
- Small cells already being deployed under LTE
- Availability of licensed/unlicensed spectrum, increasing capacity to allow for small cells
 - Small cells require backhaul – currently limited by capacity of backhaul
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- Canada's regime is PIPEDA, has many of same rules as European model but people aren't aware
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De Jong, Colby (IC)

From: Ries, Bernie (IC)
Sent: February-05-19 12:53 PM
To: De Jong, Colby (IC)
Subject: FW: First small cells (exterior building-mounted and street light pole attachments)
Attachments:

20(1)(b).21(1)(b)

As requested.

Bernie

From: Ries, Bernie (IC)
Sent: October-11-18 3:10 PM
To: IC.R WR Spectrum RSOC / RO du spectre CROS R.IC
Subject: FW: First small cells (exterior building-mounted and street light pole attachments)

Attached is some info from Rogers regarding some preliminary designs of their small cell roll out and also some info on design issues that

20(1)(b).21(1)(b)

Note that becomes readily available.

20(1)(b).21(1)(b)

Bernie

From: Brenden Smith [19(1)]@rci.rogers.com]
Sent: October-11-18 2:51 PM
To: Ries, Bernie (IC)
Subject: First small cells (exterior building-mounted and street light pole attachments)

Hi Bernie,

As requested, I'm sharing some *preliminary* designs with you.

20(1)(b)

Google Earth Image:

20(1)(b)

I'll update

you again as we get further into discussions with the City

20(1)(b)

Sincerely,

Brenden Smith, RPP
Municipal Specialist
Access Network Implementation
Mid-West Region

Rogers Communications
500 – 4th Avenue SW, Suite 700
Calgary, AB T2P 2V6

19(1)

@rci.rogers.com

m: 19(1)



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Pichette, Laura (IC)

From: Gilfillan, Fiona (IC)
Sent: January-28-19 4:45 PM
To: Hart2, Susan (IC)
Cc: Scott, Adam (IC); Parsons2, Eric (IC)
Subject: RE: Rogers [redacted] 20(1)(b).21(1)(b)

Thanks for the head's up. Please ensure that legal and DGEPS are looking at this too and set up a meeting to brief me when you are ready. [redacted] 21(1)(a).21(1)(b)

[redacted] 21(1)(a).21(1)(b)

Thanks.

Fiona

From: Hart2, Susan (IC) <susan.hart2@canada.ca>
Sent: January 28, 2019 4:30 PM
To: Gilfillan, Fiona (IC) <fiona.gilfillan@canada.ca>
Cc: Scott, Adam (IC) <adam.scott@canada.ca>; Parsons2, Eric (IC) <eric.parsons2@canada.ca>
Subject: FW: Rogers [redacted] 20(1)(b).21(1)(b)

Hi Fiona, I wanted you to be aware of Rogers request below. We are working with Adam on this. Sue

From: Parsons2, Eric (IC)
Sent: January-28-19 4:08 PM
To: Hart2, Susan (IC)
Cc: Scott, Adam (IC); Chevrier, Aline (IC); Davis2, Chantal (IC); Lander, Elisabeth (IC); STS DGSO / DGOGS SST (IC)
Subject: Rogers [redacted] 20(1)(b).21(1)(b)

Hi Sue,

Here is an update on the conf call we held earlier today with Rogers. Present on the call were myself, Aline, Chantal, and Lis.

Rogers shared with us [redacted] 20(1)(b).21(1)(b)

[redacted] 20(1)(b).21(1)(b)

Rogers have requested a response in the 2-3 week timeframe, but are open to followup conference calls at any time.

We did not comment [redacted] 20(1)(b).21(1)(b) but did ask a few clarification questions. We will review internally with LS, SLPB, DGEPS during the week and provide an update sometime next week.

Regards,

Eric Parsons

Senior Director, Spectrum Management Operations Branch
Innovation, Science and Economic Development Canada / Government of Canada
Eric.Parsons2@canada.ca / Tel: 343-291-0423 / Cell: 613-762-6557 / TTY: 1-866-694-8389

Directeur principal, Direction générale des opérations de la gestion du spectre
Innovation, Sciences et Développement économique Canada / Gouvernement du Canada
Eric.Parsons2@canada.ca / Tél: 343-291-0423 / Cell: 613-762-6557 / ATS: 1-866-694-8389

From: Joel Thorp [redacted] <[\[redacted\]@rci.rogers.com](mailto:[redacted]@rci.rogers.com)>
Sent: January 28, 2019 9:41 AM
To: Parsons2, Eric (IC) <eric.parsons2@canada.ca>
Subject: RE: Request for Call to Discuss [redacted] 20(1)(b) CONFIDENTIAL

Eric,
Attached is a confidential summary of the [redacted] 20(1)(b) to explain to you during our call at 11:00am.
Thanks and regards,
Joel

From: Joel Thorp
Sent: January 18, 2019 12:44 PM
To: 'Parsons2, Eric (IC)' <eric.parsons2@canada.ca>
Subject: Request for Call to Discuss [redacted] 20(1)(b)

Eric,
Howard and I would like to brief you [redacted] 20(1)(b) to receive your feedback.

I would be grateful if you could let me know whether you are available for a 30-minute call next week and if you could propose two or three available timeslots for us. Please note that I will not be available on Tuesday afternoon and all of Wednesday.

Thanks and regards,

Joel

Joel Thorp | Director - Spectrum Policy & Strategy | [redacted] 19(1) <[\[redacted\]@rci.rogers.com](mailto:[redacted]@rci.rogers.com)>
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