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RESILIENCE TO NATURE'S CHALLENGES

Kia manawaroa – Ngā Ākina o Te Ao Tūroa

infrastructure

RNC/QuakeCoRE Distributed Infrastructure

8th April 2019

AF8 Impact Analysis on West Coast Telecom Infrastructure using Geo-Spatial Mapping

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Draft Research Slides For Master Thesis

FARRUKH LATIF AND ANDREW AUSTIN

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

ENGINEERING
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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Outline

- **Recap from Y2018 Presentation**
  - Electricity – Communication Lifeline Infrastructure Resilience
  - Motivation and Background
  - Performance of Communication Network During NZ Earthquakes- History
  - NZ Communication Infrastructure and Services
  - Communication Exchanges(CO) and Facilities: Critical Component For Service Delivery
  - Research Objectives

- **AF8 Impact Analysis on West Coast Telecom Infrastructure using Geo Spatial Mapping**
  - Geo Spatial Map for Distributed CO to Quantify Seismic Risk
  - Seismic Risk Quantification for Communication Infrastructure
  - West Coast AF8 Impact on Communication Lifeline
  - CO Risk Quantification using Geo-Spatial Mapping (AF8 Empirical)
  - CO Risk Quantification using Geo-Spatial Mapping (AF8 Central)
  - CO Risk Quantification using Geo-Spatial Mapping (AF8 Southern)
  - CO Risk Quantification using Geo-Spatial Mapping (AF8 Northern)

- References

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RNC/QuakeCoRE Distributed Infrastructure

13th August2018

The Resiliency of Communication infrastructure during Alpine fault Earthquake scenarios in Westcoast, New Zealand

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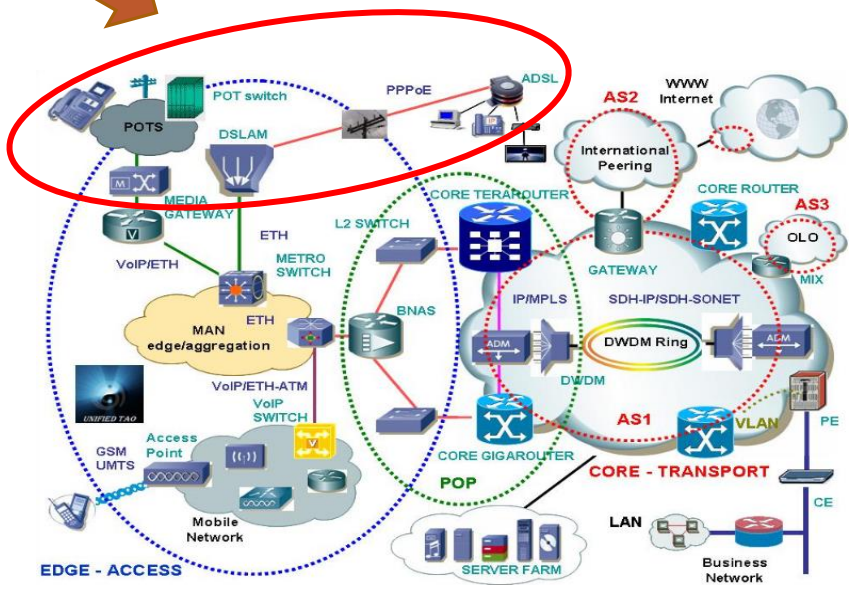
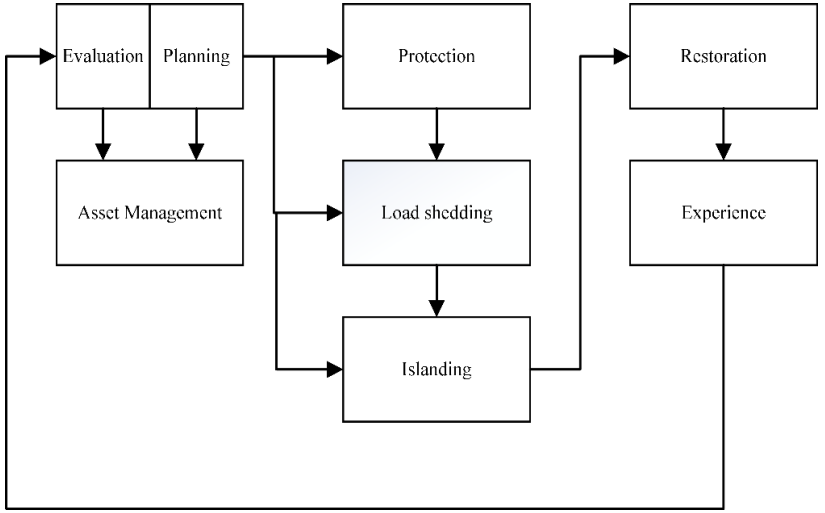
Electricity- Communication Lifeline Infrastructure Resilience

Electricity-Communication Resilience through West Coast Alpine Fault Scenario

Nirmal Nair (PI), Andrew Austin (AI), Samad Shirzadi (PhD), Duncan Maina (PhD), Yang Liu (Postdoc), Daniel Blake (Postdoc), Liam Wotherspoon (RNC DI, Lead)

Farrukh Latif(ME)





Reference [7]

"Electricity Network Assessment during Alpine Fault Event: microgrid as a solution for restoration" (Samad Shirzadi Deh Kohneh)

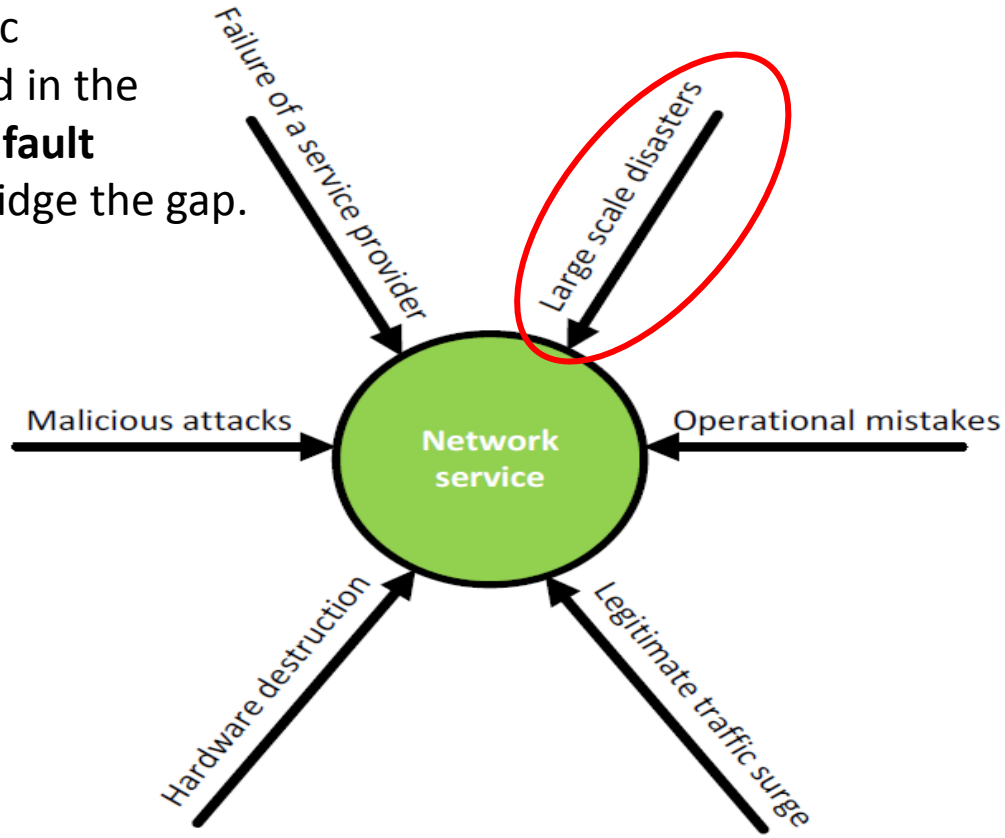
"Disaster related recovery of power networks" (Duncan Maina)

"Electric Power Distribution Systems Resilience Modelling Toolbox" (Leo Liu)

"Criticality Assessment and Asset Health management of electricity" (Ebad ur Rehram)

Motivation and Background

- In spite of the recognized critical importance, the assessment of the seismic performance for the telecommunication infrastructure is underrepresented in the literature. "**The Resiliency of Communication infrastructure during Alpine fault earthquake scenarios in Westcoast, New Zealand**" research project will bridge the gap.



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Performance of Communication Lifeline During NZ Earthquakes in the Past

Kaikora Earthquake Damages(Courtesy of Chorus)

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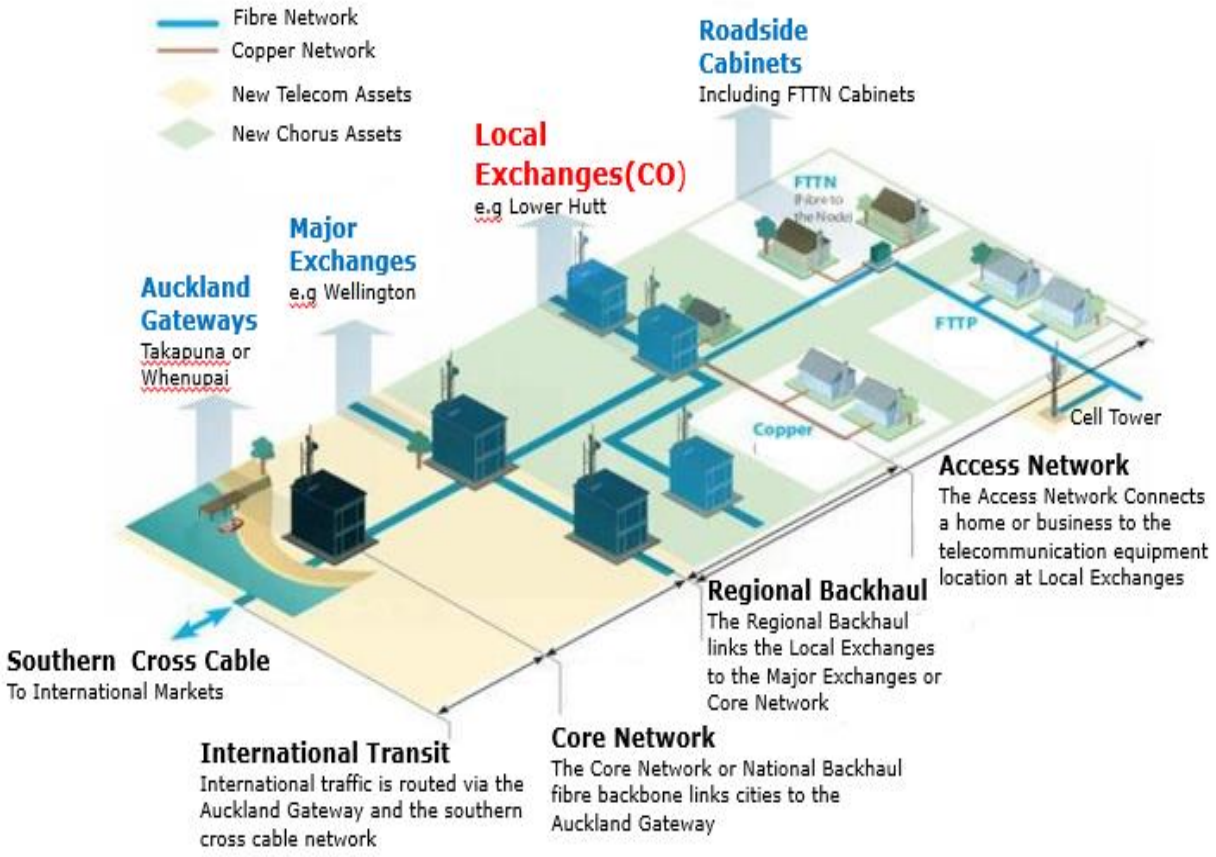
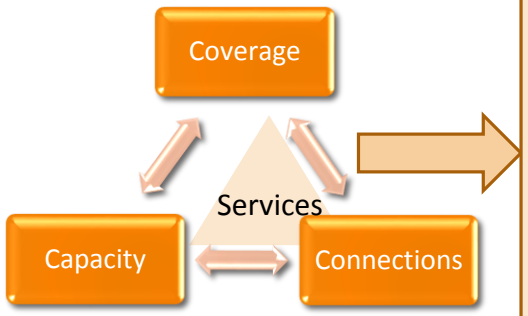
NZ Communication Infrastructure and Services





Broadband and Voice Network (Courtesy of Chorus)

- Voice
- Internet
- Cloud/Datacentres
- Enterprise Services
- Emergency Response Services
- Mission Critical Services
- Defence Services
- IOT
- VR
- AI
- TV/On Demand Content

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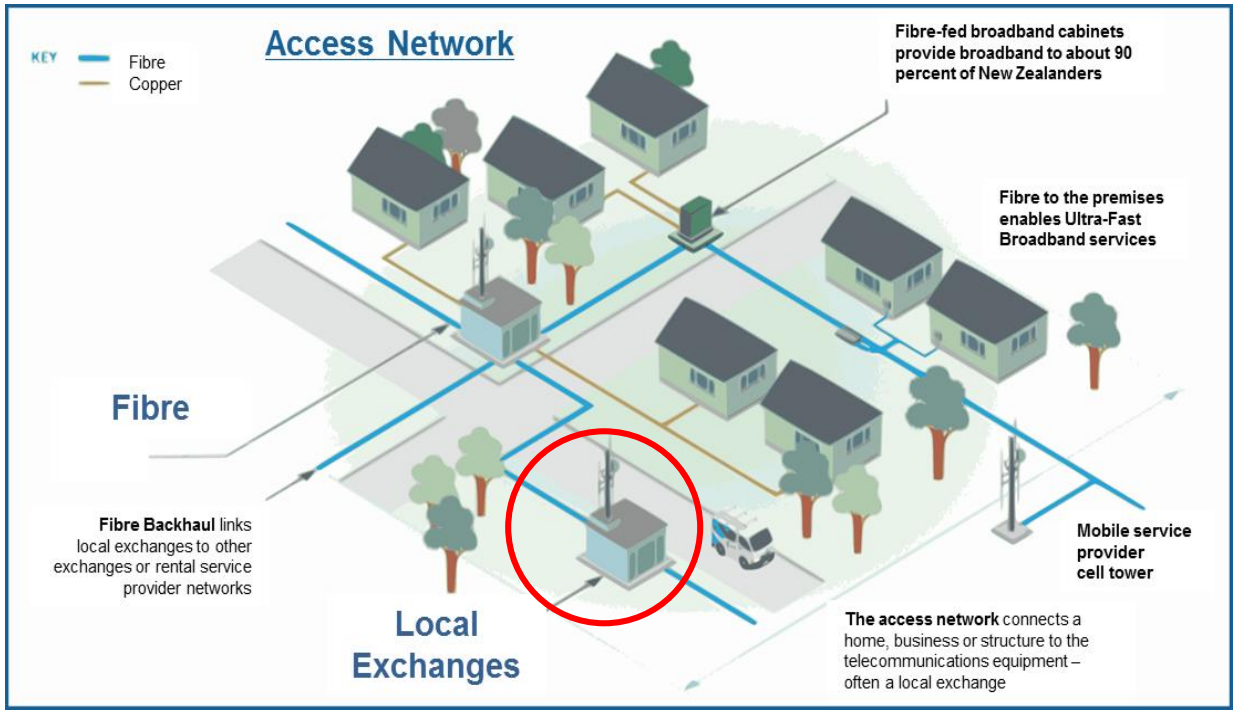
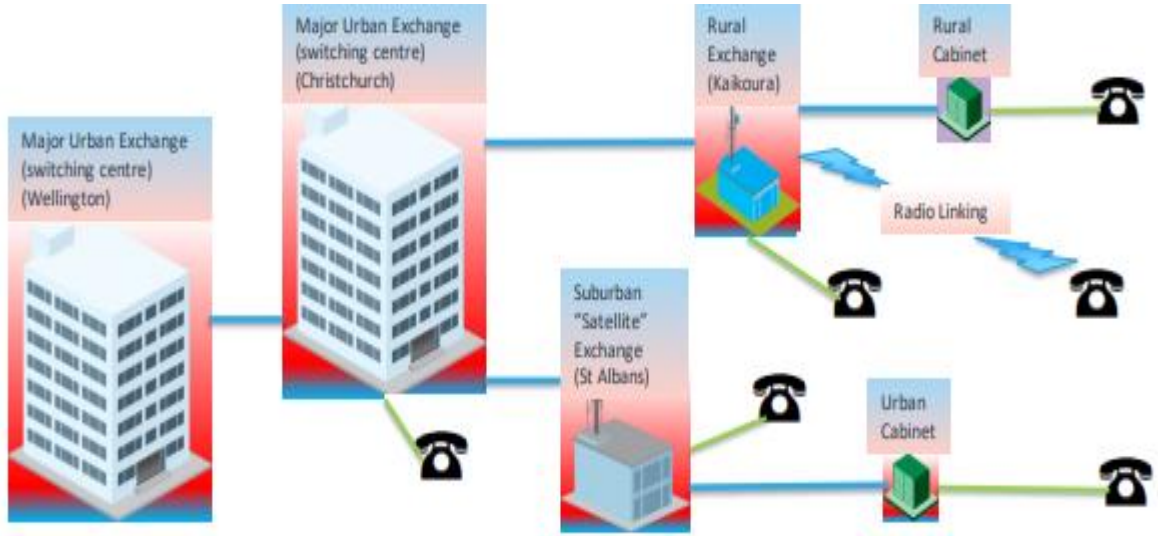
Communication Exchanges(CO) and Facilities: Critical Component For Service Delivery





Fixed Network Architecture (Courtesy of Chorus)

Research Objectives

This thesis will help to carry out the research on critical telecommunication infrastructure components **to understand and**:

RO1

Develop a seismic hazard model (using GIS tool) to quantify the risk to spatially distributed critical communication infrastructure and

i) Validate Against AF8 West Coast Scenarios

RO2

Develop a framework for Measuring Resilience in communication infrastructure for seismic hazards

RO3

Guidelines for Future Resilient Communication Network Architecture

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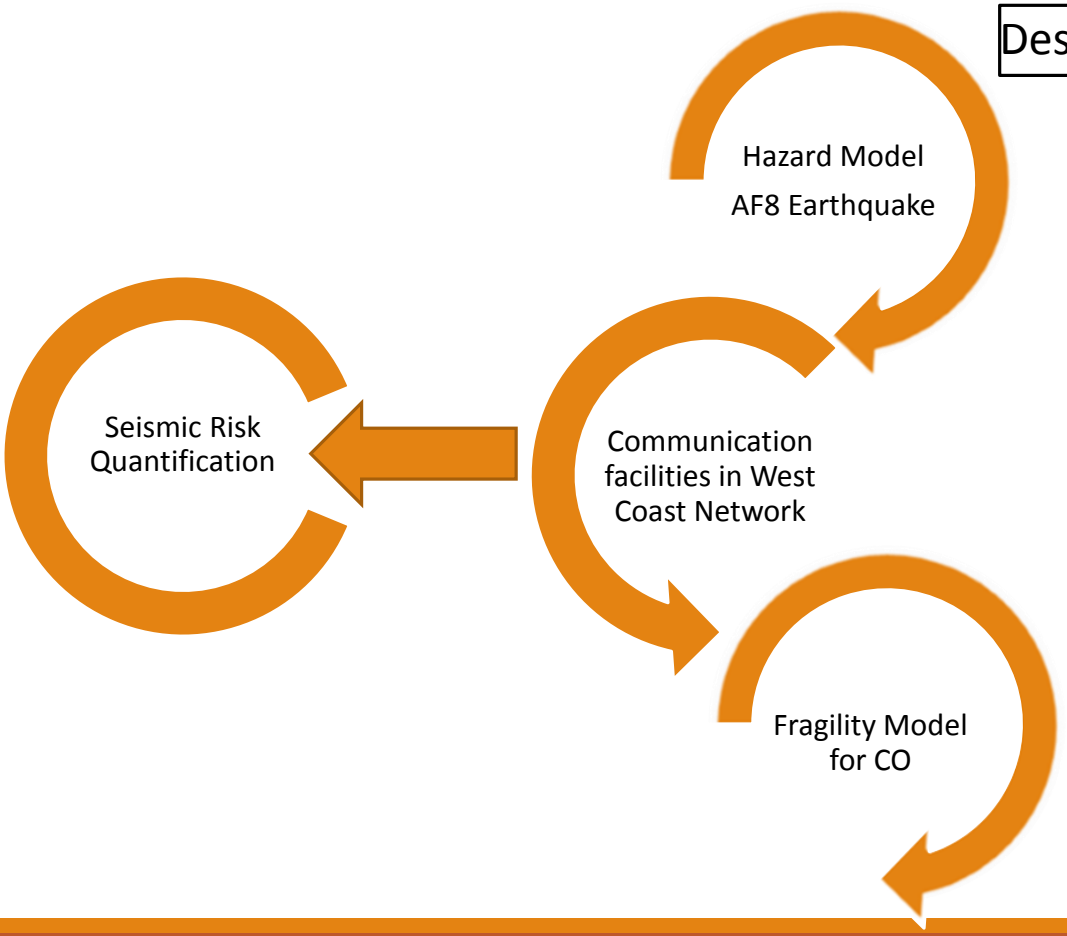
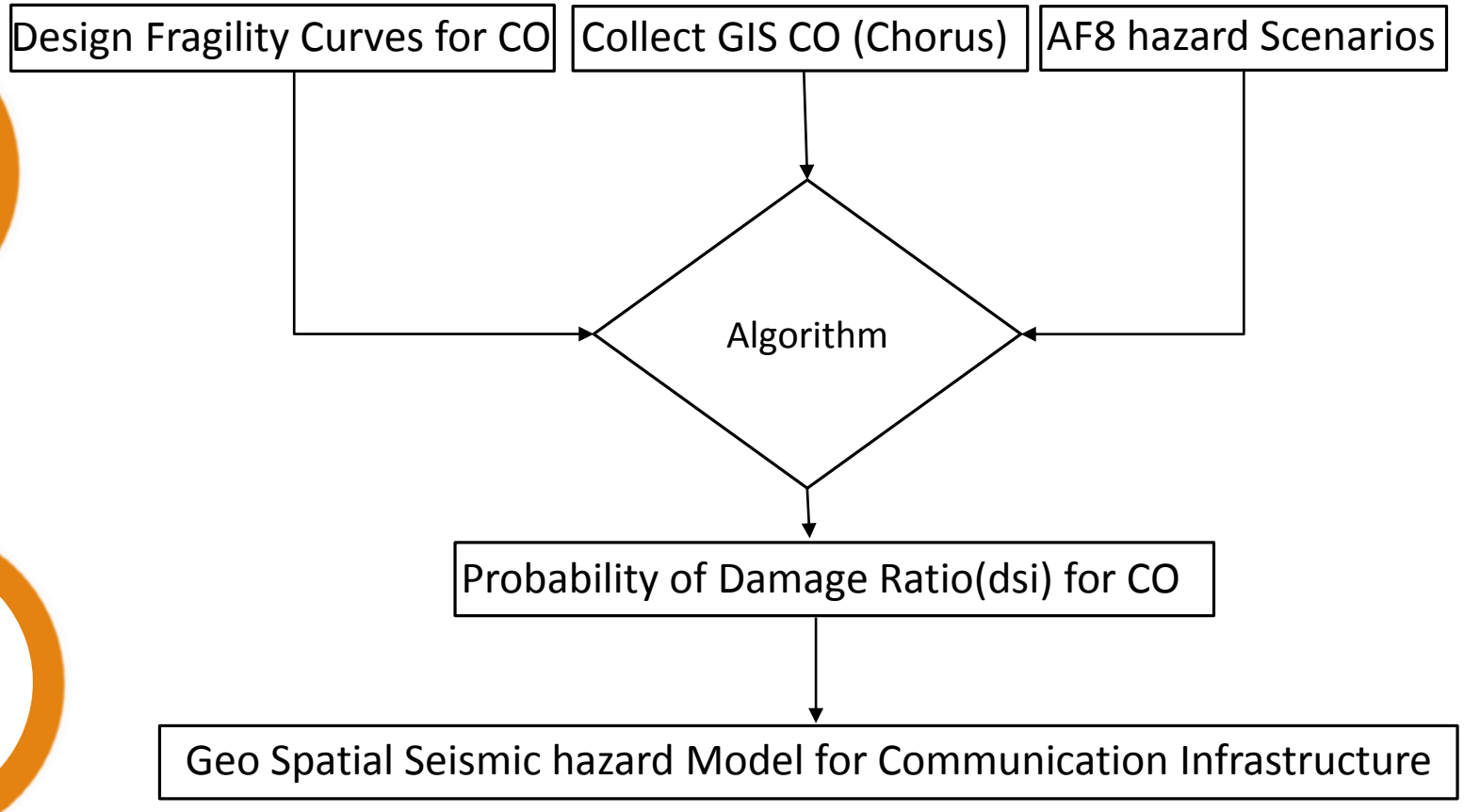
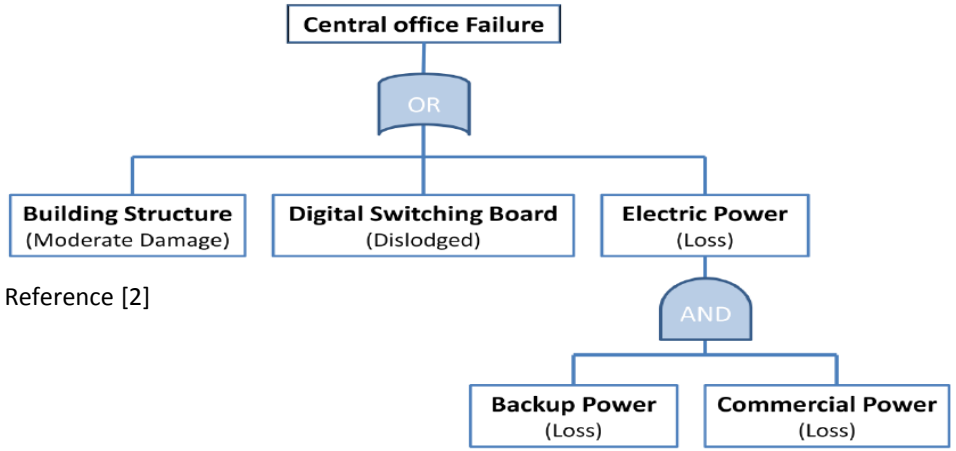
Approach and Method for Seismic Risk Quantification





Seismic Risk Quantification for Communication Infrastructure

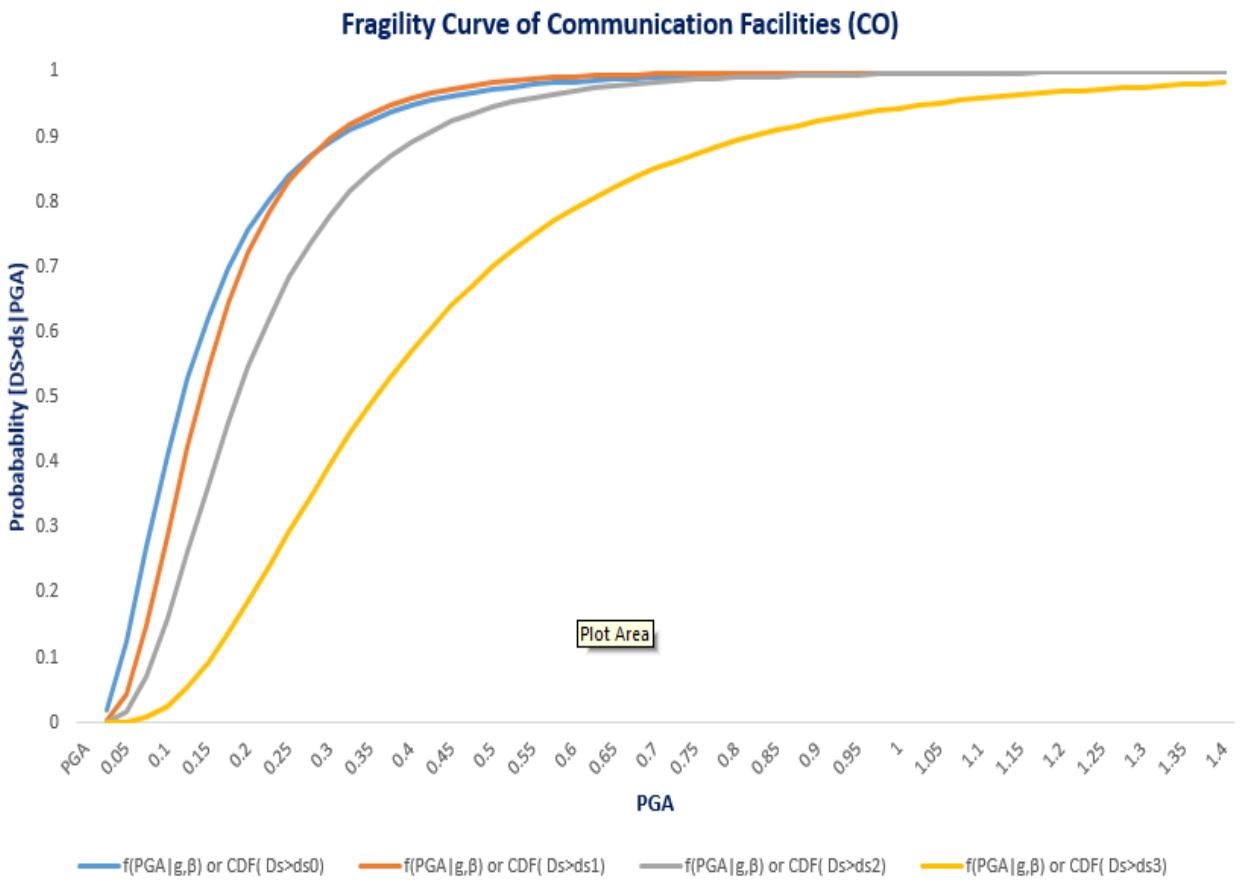


Reference [2]

$$P(E_{CO}) = P\left(E_{Structure} \cup E_{Switching\_Board} \cup \left(E_{Backup} \cap E_{Commercial}\right)\right)$$

g

β



Damage State	Description	
ds0	minor	None
ds1	moderate	Power outage for few hours or days
ds2	extensive	Few electronic boards are dislodged and need replacement
ds3	Complete	Complete Blackout

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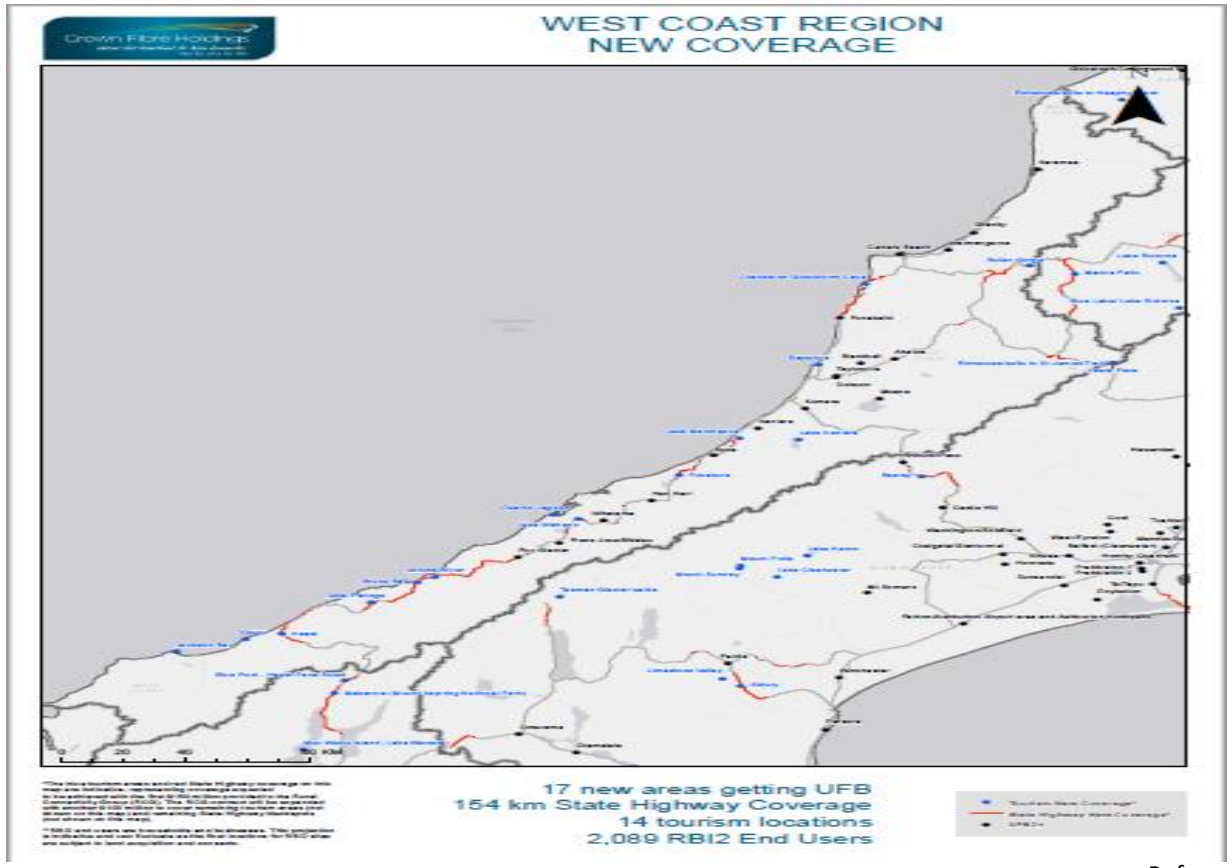
West Coast AF8 Impact on Communication Lifeline



Crown Fibre Holdings

UFB coverage by region

Region	UFB phases 1&2 premises	UFB phase 2+ premises	Total premises with UFB
Northland	39,558	5,547	45,105
Auckland	388,313	3,661	391,974
Waikato	134,253	14,668	148,921
Bay of Plenty	91,686	2,544	94,230
Gisborne	12,731	288	13,019
Taranaki	35,908	989	36,897
Hawke's Bay	47,447	1,597	49,044
Manawatu-Wanganui	75,928	4,634	80,562
Wellington	160,449	758	161,207
Nelson	23,784	3	23,787
Marlborough	14,919	678	15,597
Tasman	6,222	1,763	7,985
West Coast	8,565	2,678	11,243
Canterbury	192,115	8,699	200,814
Otago	73,491	7,380	80,871
Southland	26,638	4,336	30,974
Greenfields (To be built)	42,099	-	42,099
Total across regions	**1,374,107**	**60,222**	**1,434,329**

Note: the information in the above table is indicative only and subject to change. Crown Fibre Holdings will be working with partners to carry out more detailed planning over the coming months.

Reference [4]

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RO1

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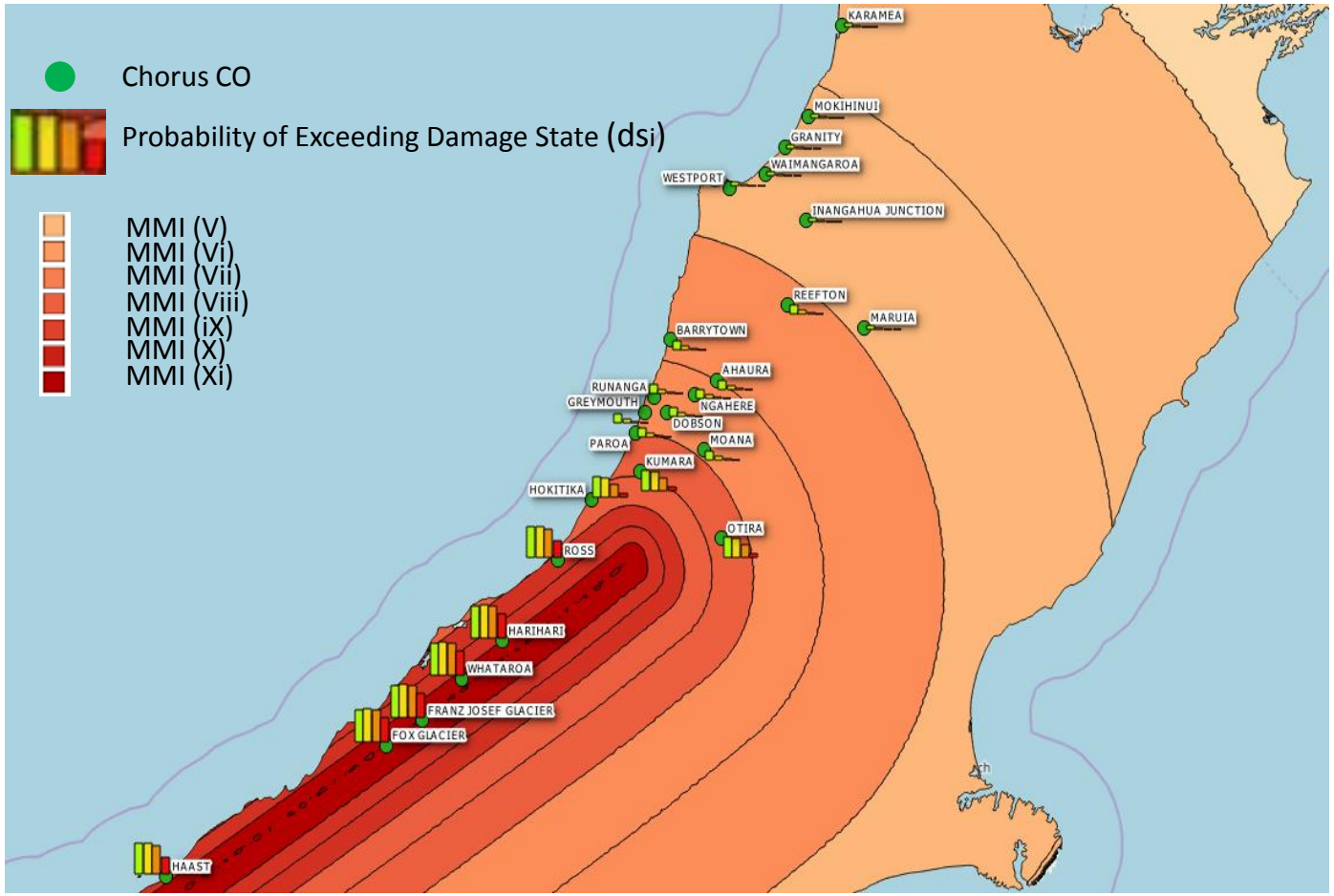
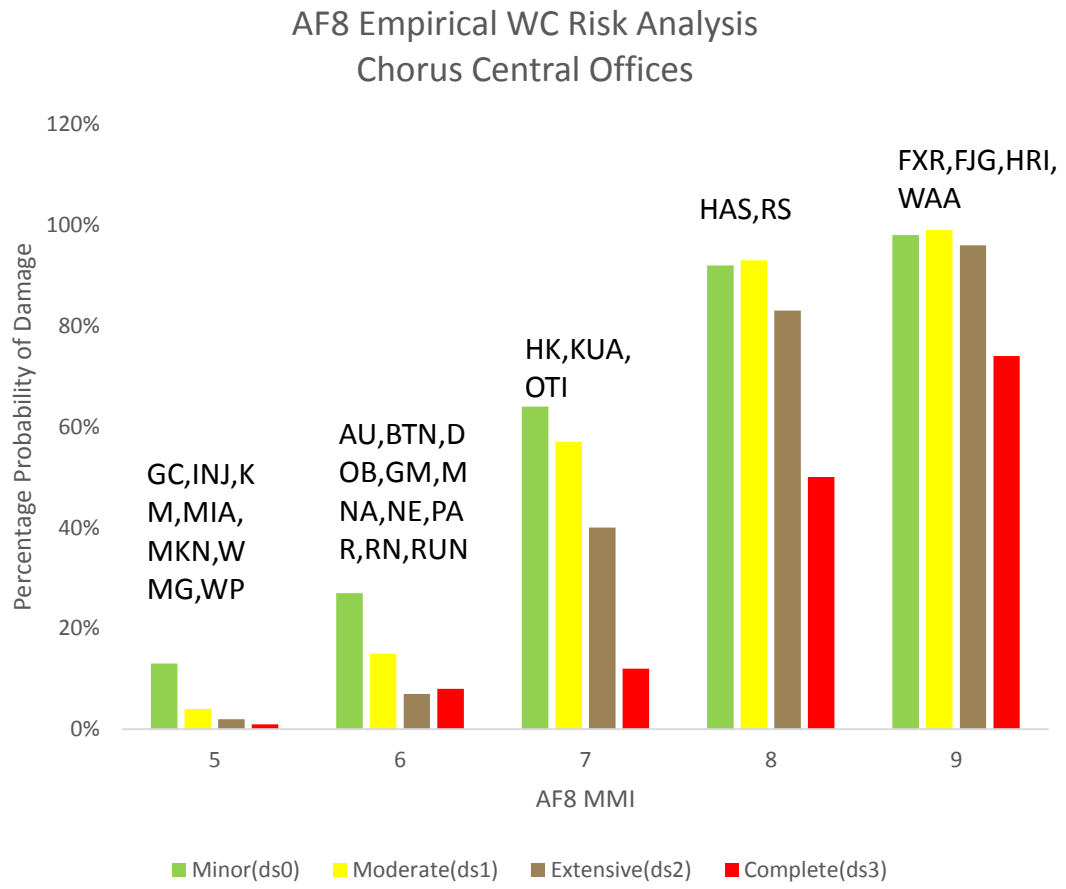
CO Risk Quantification using Geo-Spatial Mapping (AF8 Empirical)





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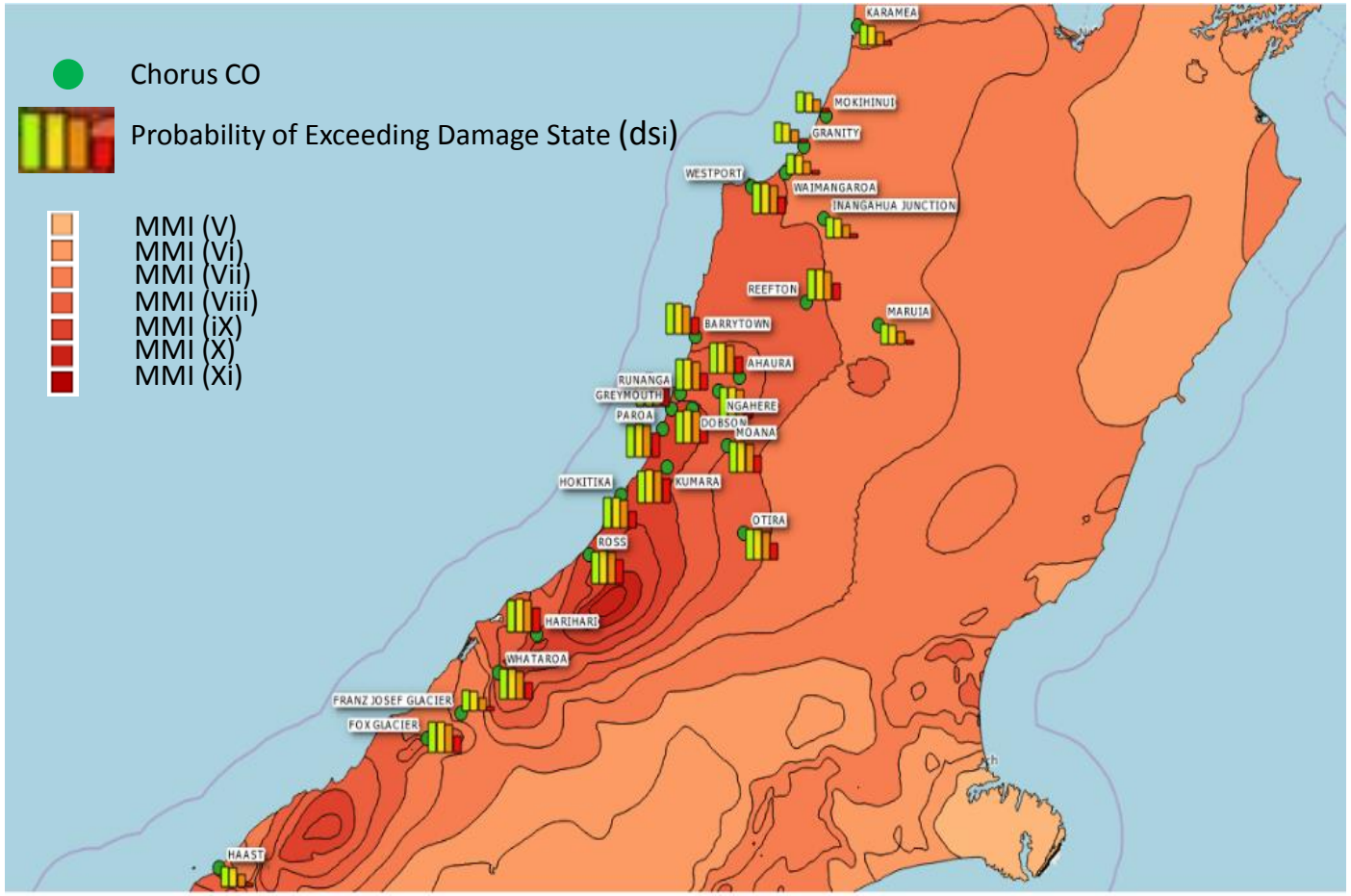
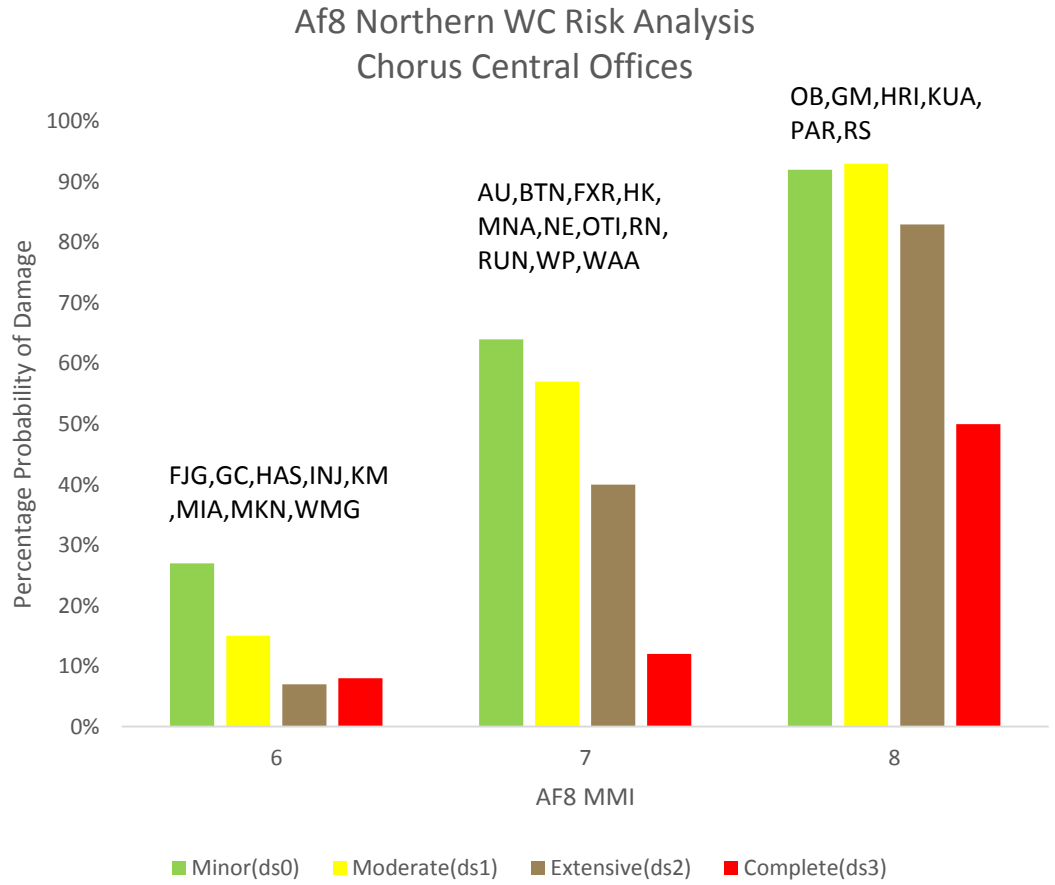
RO1

infrastructure

CO Risk Quantification using Geo-Spatial Mapping (AF8 Central)





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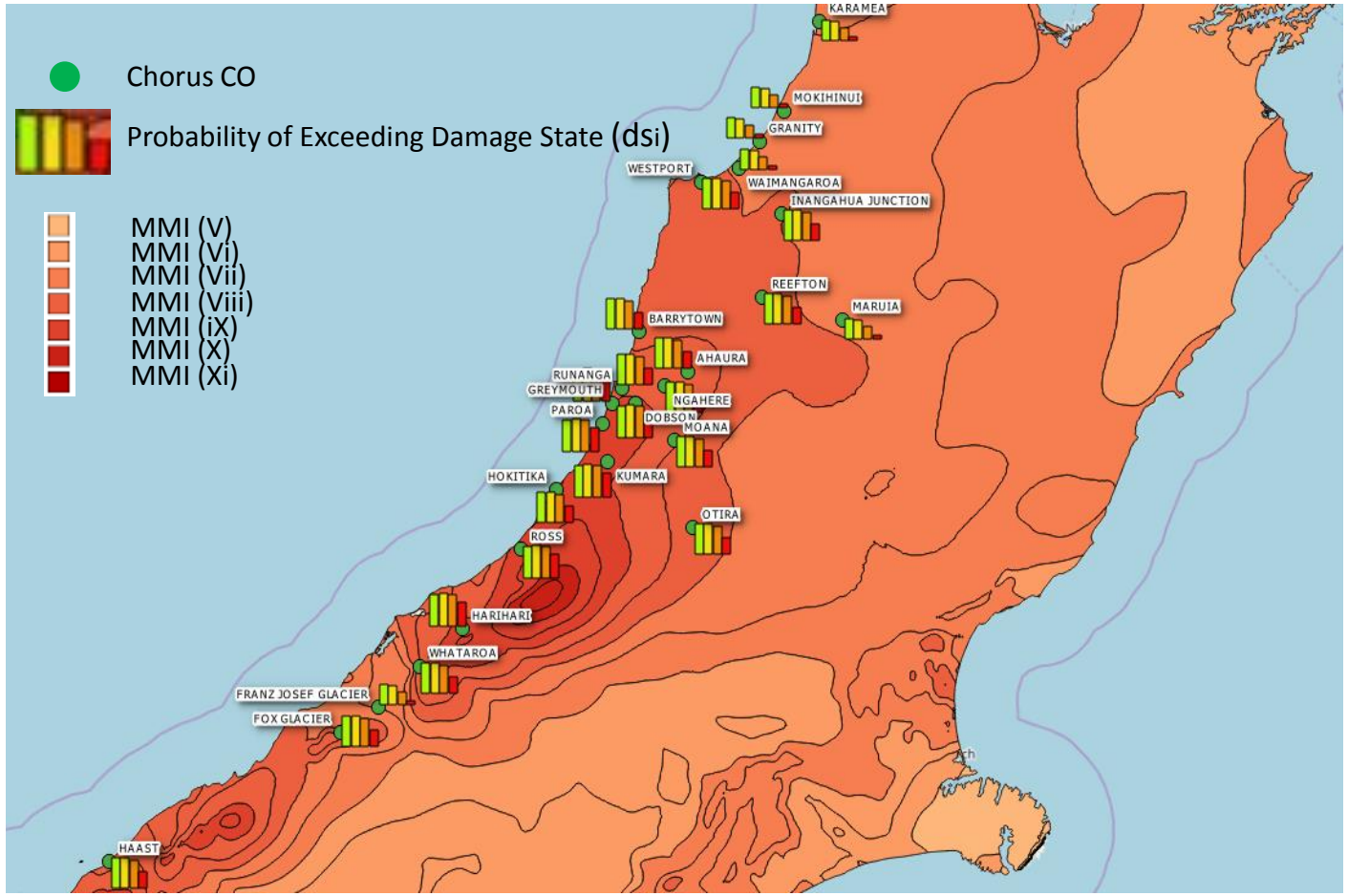
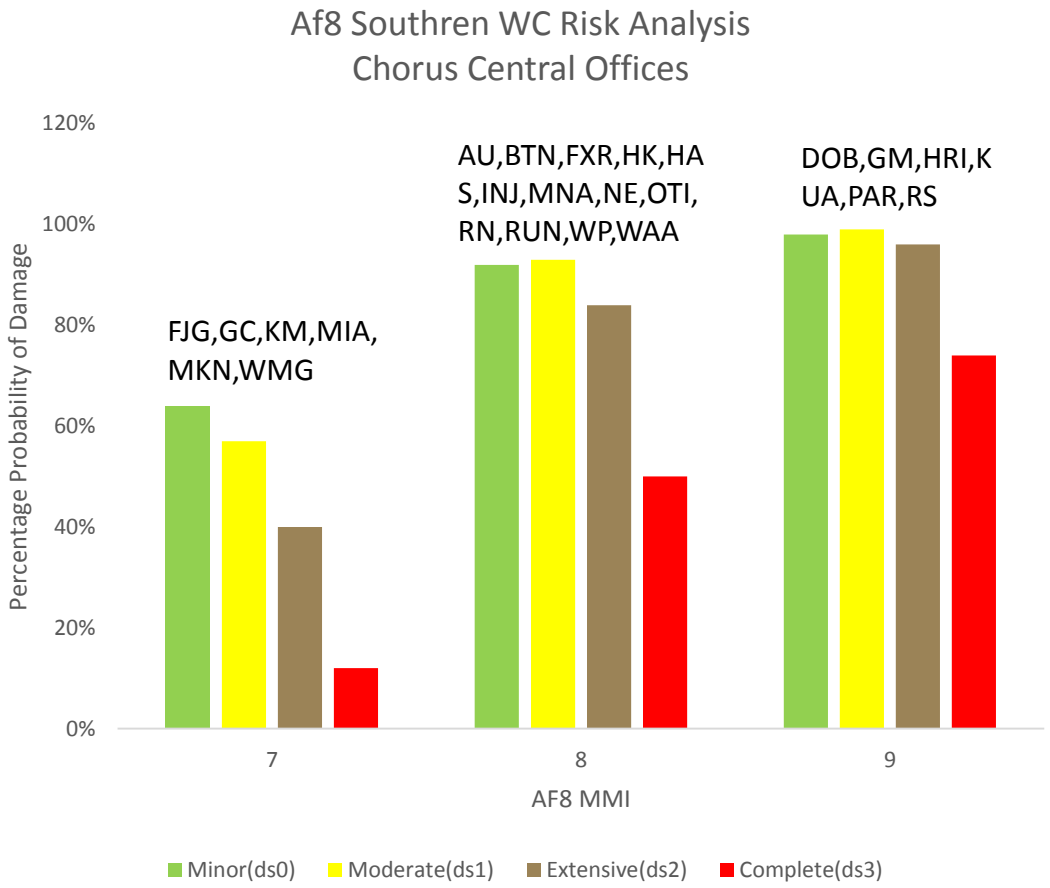
RO1

infrastructure

CO Risk Quantification using Geo-Spatial Mapping (AF8 Southern)





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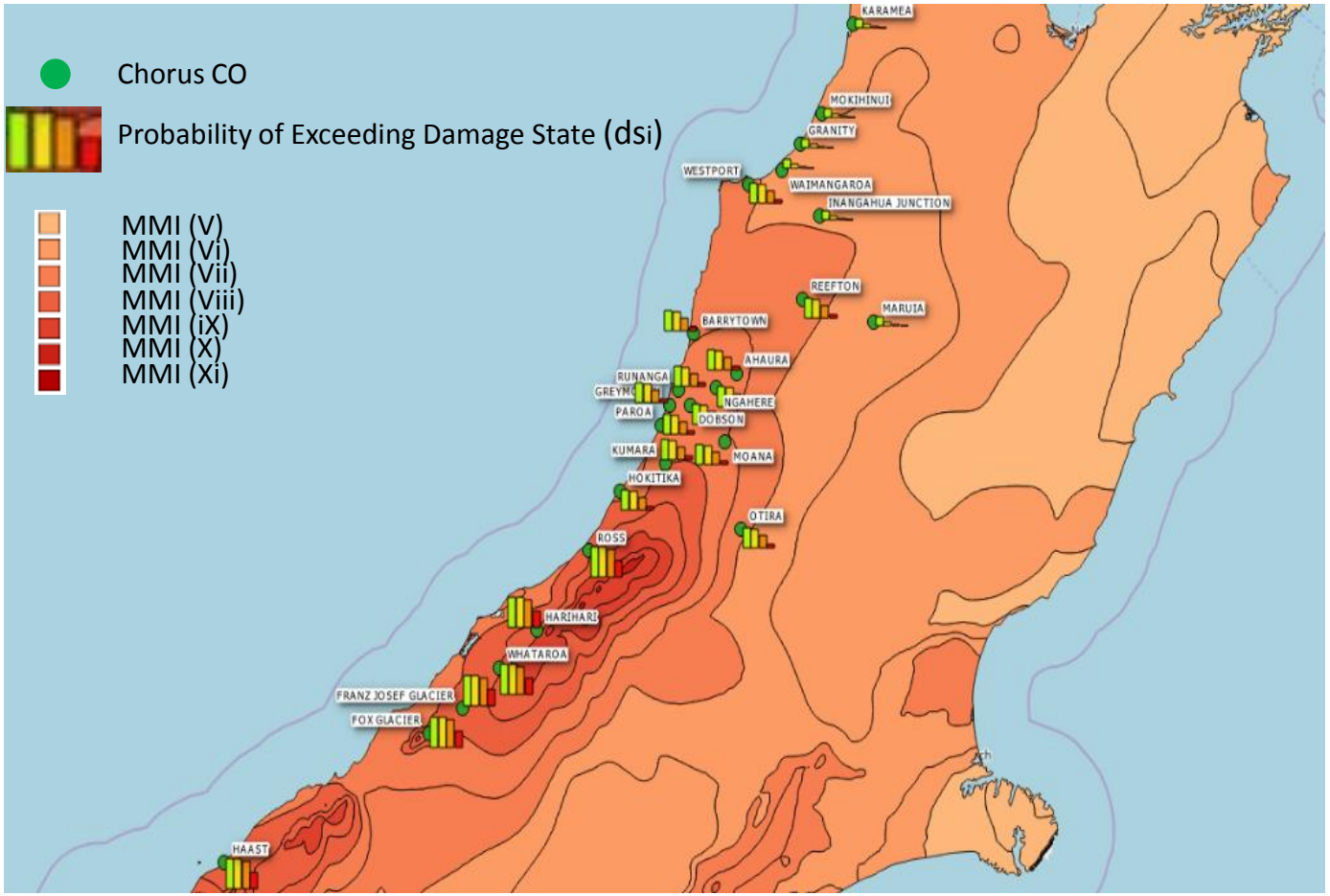
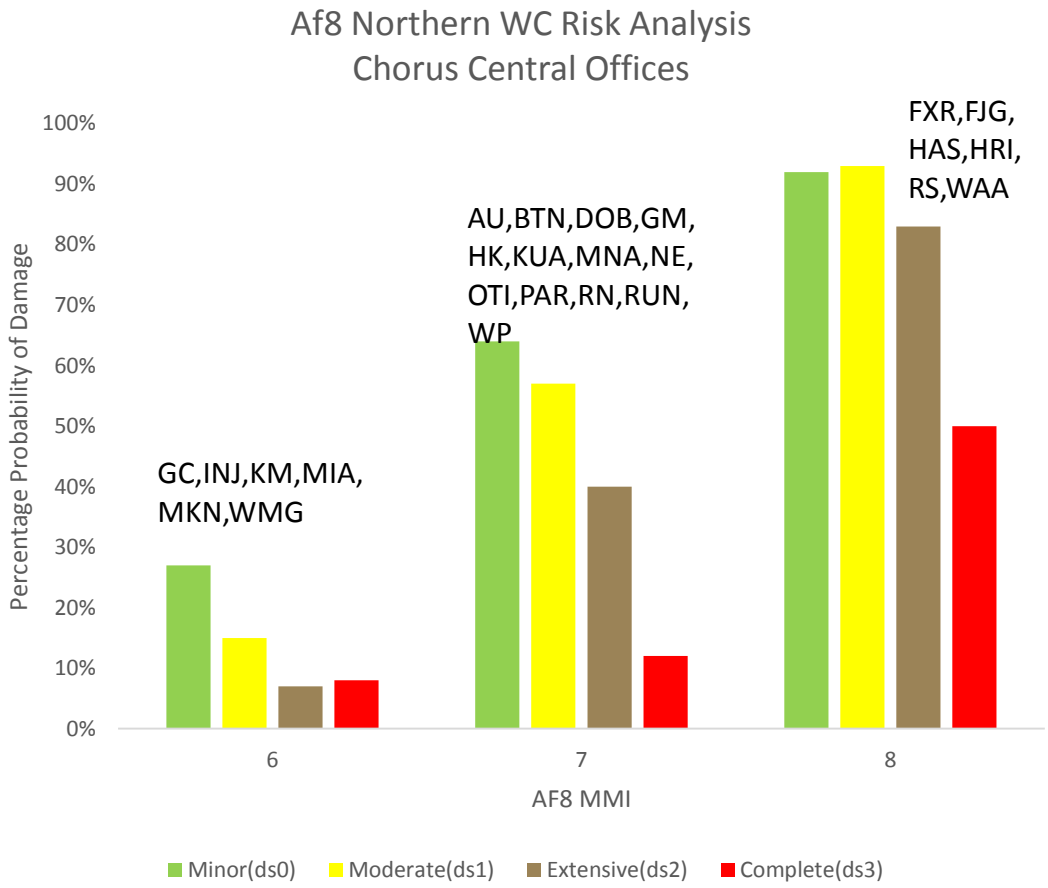
RO1

infrastructure

CO Risk Quantification using Geo-Spatial Mapping (AF8 Northern)





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Summary Results

AF8 Scnerios	MMI	Minor	Moderate	Extensive	Complete	Affected Central Offices/Telcom Infrastructure
Central	7	64%	57%	40%	12%	FJG,GC,HAS,INJ,KM,MIA,MKN,WMG
	8	92%	93%	84%	50%	AU,BTN,FXR,HK,MNA,NE,OTI,RN,RUN,WP,WAA
	9	98%	99%	96%	74%	OB,GM,HRI,KUA,PAR,RS
Northern	6	27%	15%	7%	8%	GC,INJ,KM,MIA,MKN,WMG
	7	64%	57%	40%	12%	AU,BTN,DOB,GM,HK,KUA,MNA,NE,OTI,PAR,RN,RUN,WP
	8	92%	93%	83%	50%	FXR,FJG,HAS,HRI,RS,WAA
Southern	7	64%	57%	40%	12%	FJG,GC,KM,MIA,MKN,WMG
	8	92%	93%	84%	50%	AU,BTN,FXR,HK,HAS,INJ,MNA,NE,OTI,RN,RUN,WP,WAA
	9	98%	99%	96%	74%	DOB,GM,HRI,KUA,PAR,RS
Emperical	5	13%	4%	2%	1%	GC,INJ,KM,MIA,MKN,WMG,WP
	6	27%	15%	7%	8%	AU,BTN,DOB,GM,MNA,NE,PAR,RN,RUN
	7	64%	57%	40%	12%	HK,KUA,OTI
	8	92%	93%	83%	50%	HAS,RS
	9	98%	99%	96%	74%	FXR,FJG,HRI,WAA

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[4] – Blackmore P, " Overview of Disaster Relief Systems, Network Resilience and Recovery", in ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery , Version 1.0, May 2014.

[5] – " Requirements for Network Resilience and Recovery ", ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery , May 2014.

[6] –"Network Resilience: A systematic Approach", IEEE Communication Magazine, July 2011.

[7] – Nair N, "Electricity Distribution Resilience Framework informed by West Coast Alpine Fault Scenario", Distributed Infrastructure Toolbox: NSC-RNC Project, March 2018.

[8] "Measurement Frameworks and Metrics for Resilient Networks and Services: Technical report" in European Network and Information Security Agency, Feb 2011.

[8] – Rob Ruiter, Chorus Network Specialist and www.chorus.co.nz

[9] - https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Infrastructure/How-can-we-keep-the-lights-on-during-and-after-a-natural-disaster.

[10] - https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Infrastructure.

[11] - https://www.crowninfrastructure.govt.nz/ufb-initiative/